This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

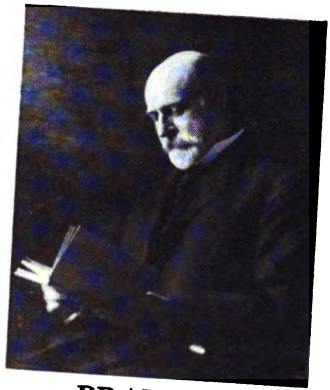
We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Digitized by Google



BRANNER
GEOLOGICAL LIBRARY

STANFORD UNIVERSITY LIBRARIES

Digitized by Google

dup

UNIVERSITY OF CALIFORNIA LIBRARY JAN 21 1921 DOCUMENT SECTION

DEPARTMENT OF THE INTERIOR
JOHN BARTON PAYNE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

WATER-SUPPLY PAPER 464

SURFACE WATER SUPPLY OF THE UNITED STATES

1917

PART XII. NORTH PACIFIC SLOPE DRAINAGE BASINS

C. LOWER COLUMBIA RIVER BASIN AND PACIFIC SLOPE DRAINAGE BASINS IN OREGON

NATHAN C. GROVER, Chief Hydraulic Engineer
F. F. HENSHAW and G. L. PARKER, District Engineers

Prepared in cooperation with the States of
OREGON AND WASHINGTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

Digitized by Google

STANFORD
JAN 21 1921
DOCUMENT DIV.

Digitized by Google

DEPARTMENT OF THE INTERIOR
JOHN BARTON PAYNE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 464

SURFACE WATER SUPPLY OF THE UNITED STATES
1917

PART XII. NORTH PACIFIC SLOPE DRAINAGE BASINS

C. LOWER COLUMBIA RIVER BASIN AND PACIFIC SLOPE DRAINAGE BASINS IN OREGON

NATHAN C. GROVER, Chief Hydraulic Engineer
F. F. HENSHAW and G. L. PARKER, District Engineers

Prepared in cooperation with the States of
OREGON AND WASHINGTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

Digitized by Google

792400

Digitized by Google

CONTENTS.

	Page.
Authorization and scope of work	7
Definition of terms	8
Explanation of data	9
Accuracy of field data and computed records	10
Cooperation	11
Division of work	12
Gaging-station records	12
Columbia River at The Dalles, Oreg	12
Tributaries of Columbia River below mouth of Snake River	14
Walla Walla River basin	14
South Fork of Walla Walla River near Milton, Oreg	14
Mill Creek near Walla Walla, Wash	15
Umatilla River basin	17
Umatilla River above Furnish reservoir, near Yoakum, Oreg	17
Umatilla River near Umatilla, Oreg	19
John Day River basin	21
John Day River near Prairie City, Oreg	21
John Day River at McDonald, Oreg	22
Strawberry Creek near Prairie City, Oreg	23
Desolation Creek near Dale, Oreg	25
Camas Creek above Cable Creek, near Ukiah, Oreg	27
Cable Creek near Ukiah, Oreg	28
Deschutes River basin	29
Deschutes River at Crane Prairie, near Lapine, Oreg	29
Deschutes River near Lapine, Oreg	30
Deschutes River below Bend, Oreg	32
Deschutes River at Mecca, Oreg	34
Deschutes River at Moody, near Biggs, Oreg	36
East Fork at Morson intake, near Lapine, Oreg	38
Arnold canal near Bend, Oreg	39
Central Oregon canal near Bend, Oreg	41
Pilot Butte canal near Bend, Oreg	42
North canal near Bend, Oreg	44
Swalley canal near Bend, Oreg	46
Tumalo Creek near Bend, Oreg	47
Tumalo feed canal near Bend, Oreg	50
Squaw Creek near Sisters, Oreg	52
Squaw Creek canal near Sisters, Oreg	53
Ochoco Creek at Elliott ranch, near Prineville, Oreg	55
Tableland ditch near Prineville, Oreg	57
Elliott ditch near Prineville, Oreg	58
Metolius River at Allingham ranger station, near Sisters, Oreg	59
Lake Creek near Sisters, Oreg	60
First Creek near Sisters, Oreg	62
Trout Creek near Antelope, Oreg	63
Warm Springs River near Warm Spring, Oreg	64
White River near Tygh Valley, Oreg	66

Digitized by Google

Gaging-station records—Continued.
Tributaries of Columbia River, etc.—Continued. Page.
Klickitat River basin 68
Klickitat River near Glenwood, Wash 68
Big Muddy Creek near Glenwood, Wash 70
Hood River basin 72
Hood River at Dee, Oreg 72
Hood River at Tucker Bridge, near Hood River, Oreg 74
Hood River at Powerdale, near Hood River, Oreg 76
East Fork of Hood River near Mount Hood, Oreg 78
East Fork of Hood River near Dee, Oreg 80
East Fork Irrigation District canal near Mount Hood, Oreg 81
Pacific Power & Light Co.'s tailrace near Hood River, Oreg 83
White Salmon River basin 84
White Salmon River at splash dam near Trout Lake, Wash 84
White Salmon River at Husum, Wash 86
White Salmon River near Underwood, Wash 87
Sandy River basin 89
Sandy River below dam near Marmot, Oreg 89
Lost Creek near Brightwood, Oreg 91
Sandy River canal near Marmot, Oreg 93
Bull Run River near Bull Run, Oreg 94
Little Sandy River near Marmot, Oreg 96
Willamette River basin 98
Middle Fork of Willamette River at Jasper, Oreg 98
Willamette River at Albany, Oreg 99
Salmon Creek near Oakridge, Oreg 100
McKenzie River at McKenzie Bridge, Oreg 102
North Santiam River at Niagara, Oreg 103
Clackamas River near Cazadero, Oreg 105
Oak Grove Fork of Clackamas River at intake near Cazadero, Oreg. 106
Lewis River basin 108
Lewis River near Amboy, Wash 108
Kalama River basin 109
Kalama River near Kalama, Wash 109
Cowlitz River basin 111
Ohanapecosh River near Lewis, Wash 111
Cowlitz River at Lewis, Wash 112
Cowlitz River at Mossy Rock, Wash 114
Clear Fork near Lewis, Wash 116
Lake Creek at outlet of Packwood Lake, near Lewis, Wash 117
Youngs River basin 119
Youngs River near Astoria, Oreg 119
Streams between Columbia River and Klamath River 120
Rogue River basin 120
Rogue River below Prospect, Oreg 120
Rogue River near Tolo, Oreg 122
California-Oregon Power Co's flume near Prospect, Oreg 124
South Fork of Little Butte Creek near Deadwood, Oreg 125
Little Butte Creek above Eagle Point, Oreg 126
Dead Indian Creek near Lilyglen, Oreg 127
North Fork of Little Butte Creek near Lake Creek, Oreg 129
Rogue River Valley canal near Brownsboro, Oreg 130
Bear Creek at Medford, Oreg 131
Phoenix ditch at Talent, Oreg 133

Digitized by Google

Gaging-station records—Continued.
Streams between Columbia River and Klamath River—Continued. Page.
Coquille River basin 134
South Fork of Coquille River at Powers, Oreg 134
Umpqua River basin 136
Umpqua River near Elkton, Oreg 136
North Umpqua River at Toketee Falls, Oreg 137
North Umpqua River near Glide, Oreg 140
Mill Creek near Ash, Oreg 142
Miscellaneous discharge measurements 144
Index 147
Appendix: Gaging stations and publications relating to water resources I

ILLUSTRATIONS.

Page.
PLATE I. *A*, Price current meters; *B*, Typical gaging station 8
II. Water-stage recorders: *A*, Stevens continuous; *B*, Gurley printing; *C*, Friez 9

Digitized by Google

Digitized by Google

SURFACE WATER SUPPLY OF LOWER COLUMBIA RIVER AND PACIFIC SLOPE DRAINAGE BASINS IN OREGON, 1917.

AUTHORIZATION AND SCOPE OF WORK.

This volume is one of a series of 14 reports presenting records of measurements of flow made on streams in the United States during the year ending September 30, 1917.

The data presented in these reports were collected by the United States Geological Survey under the following authority contained in the organic law (20 Stat. L., p. 394):

Provided, That this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

The work was begun in 1888 in connection with special studies relating to irrigation in the arid West. Since the fiscal year ending June 30, 1895, successive sundry civil bills passed by Congress have carried the following item and appropriations:

For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

Annual appropriations for the fiscal years ending June 30, 1895–1918.

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911 to 1917, inclusive	150,000
1918	175,000

In the execution of the work many private and State organizations have cooperated either by furnishing data or by assisting in collecting data. Acknowledgments for cooperation of the first kind are made in connection with the description of each station affected; cooperation of the second kind is acknowledged on page 11.

Measurements of stream flow have been made at about 4,240 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1917, 1,180 gaging stations were being maintained by the Survey and the cooperating organizations.

Digitized by Google

Many miscellaneous discharge measurements are made at other points. In connection with this work data were also collected in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in water-supply papers from time to time. Information in regard to publications relating to water resources is presented in the appendix to this report.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups—(1) those that represent a rate of flow, as second-feet, gallons per minute, miners' inches, and discharge in second-feet per square mile, and (2) those that represent the actual quantity of water, as run-off in depth in inches, acre-feet, and millions of cubic feet. The principal terms used in this series of reports are second-feet, second-feet per square mile, run-off in inches, acre-feet, and millions of cubic feet. They may be defined as follows:

"Second-feet" is an abbreviation for "cubic feet per second." A second-foot is the rate of discharge of water flowing in a channel of rectangular cross-section 1 foot wide and 1 foot deep at an average velocity of 1 foot per second. It is generally used as a fundamental unit from which others are computed.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off (depth in inches)" is the depth to which an area would be covered if all the water flowing from it in a given period were uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

An "acre-foot," equivalent to 43,560 cubic feet, is the quantity required to cover an acre to the depth of 1 foot. The term is commonly used in connection with storage for irrigation.

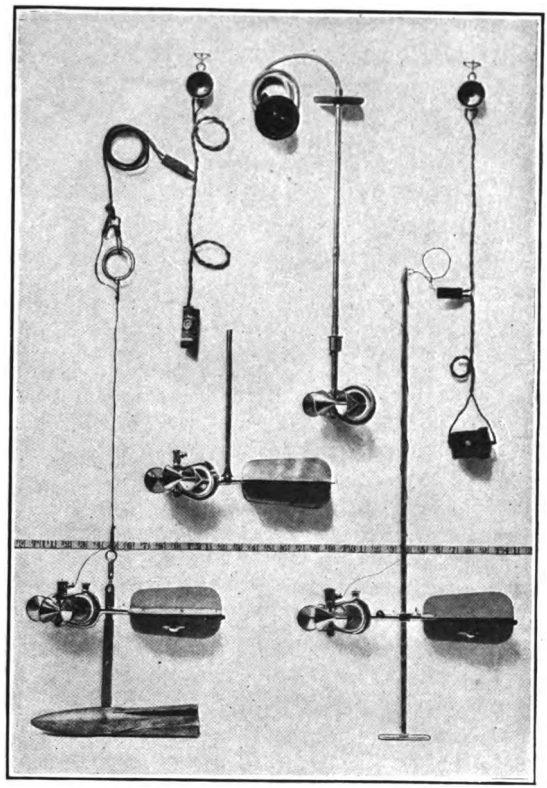
The following terms not in common use are here defined:

"Stage-discharge relation," an abbreviation for the term "relation of gage height to discharge."

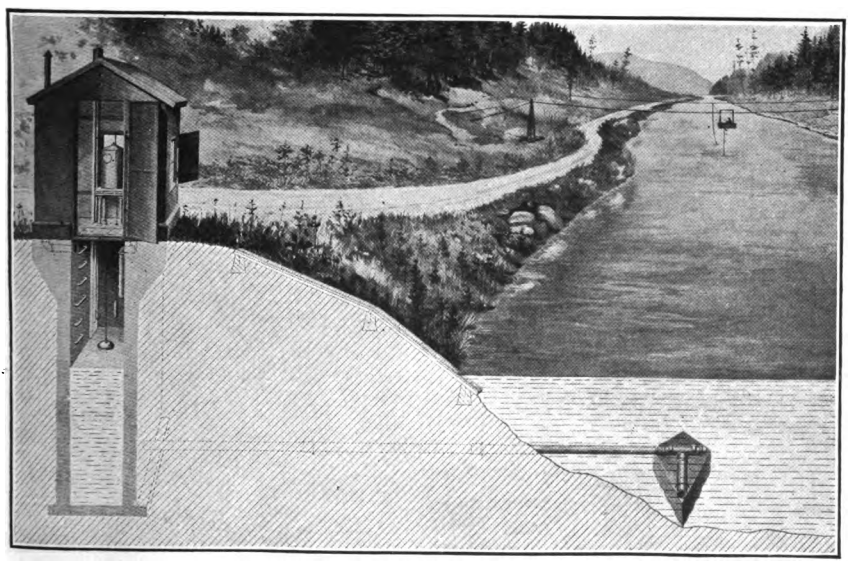
"Control," a term used to designate the section or sections of the stream channel below the gage which determine the stage-discharge relation at the gage. It should be noted that the control may not be the same section or sections at all stages.

The "point of zero flow" for a gaging station is that point on the gage—the gage height—to which the surface of the river would fall if there were no flow.

Digitized by Google

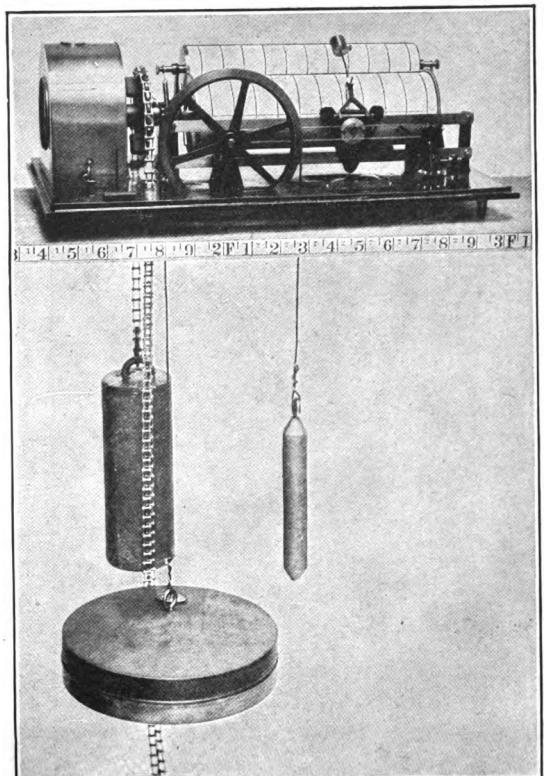


A. PRICE CURRENT METERS.

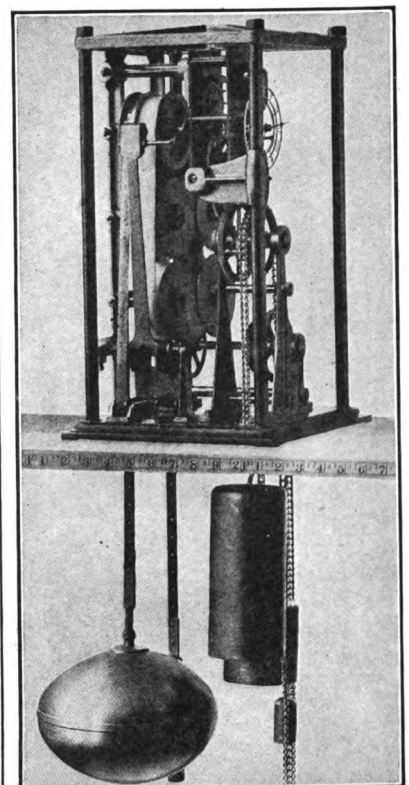


B. TYPICAL GAGING STATION.

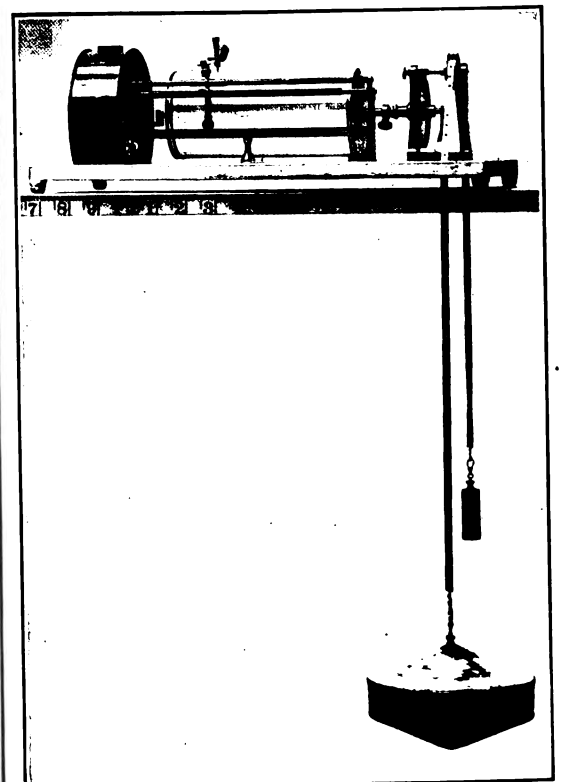
Digitized by Google



A STEVENS CONTINUOUS.



B. GURLEY PRINTING.



C. FRIEZ.

WATER-STAGE RECORDERS.

Digitized by Google

EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1916, and ending September 30, 1917. At the beginning of January in most parts of the United States much of the precipitation in the preceding three months is stored as ground water in the form of snow or ice, or in ponds, lakes, and swamps, and this stored water passes off in the streams during the spring break-up. At the end of September, on the other hand, the only stored water available for run-off is possibly a small quantity in the ground; therefore the run-off for the year beginning October 1 is practically all derived from precipitation within that year.

The base data collected at gaging stations consist of records of stage, measurements of discharge, and general information used to supplement the gage heights and discharge measurements in determining the daily flow. The records of stage are obtained either from direct readings on a staff gage or from a water-stage recorder that gives a continuous record of the fluctuations. Measurements of discharge are made with a current meter by the general methods outlined in standard textbooks on the measurement of river discharge. (See Pls. I, II.)

From the discharge measurements rating tables are prepared that give the discharge for any stage, and these rating tables, when applied to the gage heights, give the discharge from which the daily, monthly, and yearly means of discharge are determined.

The data presented for each gaging station in the area covered by this report comprise a description of the station, a table giving records of discharge measurements, a table showing the daily discharge of the stream, and a table of monthly and yearly discharge and run-off.

If the base data are insufficient to determine the daily discharge, tables giving daily gage height and records of discharge measurements are published.

The description of the station gives, in addition to statements regarding location and equipment, information in regard to any conditions that may affect the permanence of the stage-discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of control, and the cause and effect of backwater. It gives also information as to diversions that decrease the flow at the gage, artificial regulation, maximum and minimum recorded stages, and the accuracy of the records.

The table of daily discharge gives, in general, the discharge in second-feet corresponding to the mean of the gage heights read each day. At stations on streams subject to sudden or rapid diurnal fluctuation the discharge obtained from the rating table and the mean daily gage height may not be the true mean discharge for the

Digitized by Google

day. If such stations are equipped with water-stage recorders the mean daily discharge may be obtained by averaging discharge at regular intervals during the day or by use of the discharge integrator, an instrument operating on the principle of the planimeter and containing as an essential element the rating curve of the station.

In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. As the gage height is the mean for the day it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently larger than given in the maximum column. Likewise, in the column headed "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet per second during the month. On this average flow are based computations recorded in the remaining columns, which are defined on page 8.

ACCURACY OF FIELD DATA AND COMPUTED RECORDS.

The accuracy of stream-flow data depends primarily (1) on the permanence of the stage-discharge relation, and (2) on the accuracy of observation of stage, measurements of flow, and interpretation of records.

A paragraph in the description of the station gives information regarding the (1) permanence of the stage-discharge relation, (2) precision with which the discharge rating curve is defined, (3) refinement of gage readings, (4) frequency of gage readings, and (5) methods of applying daily gage height to the rating table to obtain the daily discharge.

For the rating tables "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The monthly means for any station may represent with high accuracy the quantity of water flowing past the gage, but the figures showing discharge per square mile and depth of run-off in inches may be subject to gross errors caused by the inclusion of large noncontributing districts in the measured drainage area, by lack of information concerning water diverted for irrigation or other use, or by inability to interpret the effect of artificial regulation of the flow of the river above the station. "Second-feet per square mile" and "Run-off (depth in inches)" are therefore not computed if such errors appear probable. The computations are also omitted for stations on streams draining areas in which the annual rainfall is less

Digitized by Google

than 20 inches. All figures representing "second-feet per square mile" and "run-off (depth in inches)" previously published by the Survey should be used with caution because of possible inherent sources of error not known to the Survey.

The table of monthly discharge gives only a general idea of the flow at the station and should not be used for other than preliminary estimates; the tables of daily discharge allow more detailed studies of the variation in flow. It should be borne in mind, however, that the observations in each succeeding year may be expected to throw new light on data previously published.

COOPERATION.

The work in Oregon and Washington was carried on under cooperative agreements between the United States Geological Survey and the respective States.

Cooperation with the States is effected under contracts which are made between the Director of the United States Geological Survey and the State engineers or other officials and are authorized by legislative acts appropriating moneys.

Acknowledgments are due to John H. Lewis, State engineer of Oregon, and to Henry Landes, State geologist of Washington, for the efficient manner in which they represented their States in the cooperative investigations.

Acknowledgements are also due to the United States Reclamation Service, the United States Forest Service, and the United States Office of Indian Affairs for assistance, suggestions, and the freest use of data gathered exclusively for them and paid for by them; to the Corps of Engineers, United States Army; and to the United States Weather Bureau for hydrographic and climatic data.

Special acknowledgments are due for financial assistance rendered by municipalities, corporations, and individuals, as follows: Water masters for Umatilla, Crook, and Deschutes Counties, Water Bureau of the city of Portland, Tumalo Project of the State of Oregon, Teel Irrigation District, Ochoco Irrigation District, Suttle Lake Irrigation District, East Fork Irrigation District, Talent Irrigation District, Horse Heaven Irrigation District, Furnish Ditch Co., Prairie Power Co., Pacific Power & Light Co., Central Oregon Irrigation Co., Arnold Irrigation Co., Northwestern Electric Co., Portland Railway, Light & Power Co., Waldo Lake Irrigation & Power Co., O'Neil Bros. & Callaghan, North Coast Power Co., Crown-Willamette Paper Co., California-Oregon Power Co., Rogue River Valley Canal Co., M. A. Moody, Carl Bieberstedt, and J. G. Kelley.

Acknowledgment is made in descriptions of gaging stations for records furnished.

Digitized by Google

DIVISION OF WORK.

The data for stations in Oregon and Washington, except those in Walla Walla River and Cowlitz River basins in Washington, were collected and prepared for publication under the direction of F. F. Henshaw, district engineer, assisted by C. L. Batchelder, J. E. Stewart, W. E. Dickinson, and R. C. Briggs.

Data for stations in Walla Walla River and Cowlitz River basins in Washington were collected and prepared for publication under the direction of G. L. Parker, district engineer, assisted by Lasley Lee, C. O. Brown, C. G. Paulsen, J. E. Stewart, J. T. Hartson, John McCombs, and L. D. Carson.

The records were reviewed and the manuscript assembled by W. E. Dickinson.

GAGING-STATION RECORDS.

COLUMBIA RIVER AT THE DALLES, OREG.

LOCATION.—In sec. 34, T. 2 N., R. 13 E., 2,000 feet below ferry at The Dalles, about 18 miles below Deschutes River, and above Hood and Klickitat rivers.

DRAINAGE AREA.—237,000 square miles.

RECORDS AVAILABLE.—June 1, 1878, to September 30, 1917. Maximum stages 1858 to 1877.

GAGE.—Two gages at The Dalles: The Government or Brooks gage, used by the United States Geological Survey made up of several sections attached to the piling of viaduct connecting Regulator Dock with the warehouse; the United States Army engineers' gage, similar in form but with a datum of 8.9 feet lower than the Brooks gage. Gage at Cascade Locks, 20 miles below The Dalles, which was used in computing early records, has been situated at various points but is at present attached to side of wooden fender of upper locks chamber between upper guard and lock gates. Elevation of datum of Brooks gage, 46.36 feet (adjustment of primary level net, 1912).

DISCHARGE MEASUREMENTS.—In 1903, made by United States Army engineers with rod floats and meter from a steamer; in 1907, by United States Geological Survey engineers with meter from a launch; in 1908, float measurements by United States Geological Survey engineers 2,000 feet below gage at The Dalles; in 1910 and 1913, measurements by United States Geological Survey engineers on Columbia River above Snake River and on Snake River referred to The Dalles gage, allowance being made for intervening tributaries.

CHANNEL AND CONTROL.—Rocky and permanent at the rapids at Cascade Locks, the control for all three gages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 40.4 feet, June 20 (discharge, 727,000 second-feet); minimum stage recorded, —1.0 foot January 19 to 21 (discharge, 56,800 second-feet).

1857–1917: Maximum stage recorded, 59.6 feet June 6, 1894 (discharge, 1,170,000 second-feet); minimum stage recorded, —3.9 feet on gage at Cascade Locks January 7, 1890 (discharge, 41,900 second-feet).

ICE.—Stage-discharge relation possibly affected by ice for short periods in December and January.

DIVERSIONS.—Quantity of water diverted for irrigation is large in the aggregate but constitutes only a small proportion of the total flow; the low-water flow, which comes in the winter, is little affected.

REGULATION.—None.

Digitized by Google

ACCURACY.—Stage-discharge relation practiclly permanent; ice jams in river December 30 and 31, and January 17 to 22 but open water rating assumed applicable. Rating curve well defined between 80,000 and 900,000 second-feet. Gage read to tenths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records excellent, except July to September, which are shown by comparison with records at Cascade Locks to be somewhat uncertain.

COOPERATION.—Gage readings furnished by United States Weather Bureau.

No discharge measurements during year.

Daily discharge, in second-feet, of Columbia River at The Dalles, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	120,000	91,000	79,400	63,400	62,000	69,000	93,000	264,000	688,000	644,000	297,000	159,000
2	118,000	91,000	78,600	64,800	62,000	72,200	97,000	257,000	673,000	627,000	289,000	156,000
3	116,000	90,100	79,400	69,800	62,000	74,600	100,000	246,000	662,000	611,000	281,000	155,000
4	113,000	92,000	79,400	70,600	66,200	76,200	99,000	240,000	655,000	602,000	273,000	152,000
5	112,000	92,000	78,600	71,400	67,600	74,600	100,000	233,000	640,000	596,000	264,000	150,000
6	111,000	91,000	81,100	74,600	66,200	72,200	100,000	234,000	624,000	596,000	255,000	146,000
7	107,000	92,000	81,100	73,800	66,200	69,800	111,000	240,000	607,000	587,000	245,000	142,000
8	105,000	93,000	80,200	73,800	68,300	67,600	137,000	243,000	594,000	576,000	232,000	135,000
9	103,000	95,000	79,400	73,000	69,000	66,900	156,000	255,000	596,000	572,000	225,000	134,000
10	102,000	93,000	77,800	72,200	69,000	66,900	170,000	278,000	611,000	564,000	218,000	131,000
11	102,000	90,100	77,800	71,400	69,800	66,200	176,000	302,000	653,000	553,000	212,000	129,000
12	102,000	86,500	76,200	70,600	70,600	66,200	176,000	322,000	664,000	543,000	204,000	126,000
13	102,000	85,600	75,400	68,300	69,000	65,500	177,000	349,000	646,000	526,000	199,000	124,000
14	102,000	85,600	73,800	66,900	69,000	66,900	199,000	379,000	622,000	503,000	195,000	121,000
15	103,000	83,800	74,600	65,500	69,600	66,200	201,000	403,000	605,000	487,000	187,000	118,000
16	104,000	81,100	76,200	63,400	73,000	65,500	202,000	435,000	600,000	477,000	184,000	115,000
17	105,000	79,400	74,600	59,900	70,600	64,800	195,000	483,000	620,000	463,000	183,000	112,000
18	103,000	78,600	73,800	57,400	70,600	65,500	188,000	475,000	668,000	451,000	178,000	111,000
19	101,000	77,800	74,600	56,800	69,800	65,500	176,000	449,000	716,000	439,000	176,000	110,000
20	97,000	77,000	74,600	56,800	69,000	66,200	168,000	433,000	727,000	428,000	173,000	108,000
21	96,000	77,800	73,000	56,800	71,400	66,900	168,000	426,000	718,000	416,000	170,000	107,000
22	91,000	78,600	72,200	58,000	70,600	66,200	172,000	428,000	709,000	407,000	168,000	107,000
23	89,200	79,400	73,800	59,200	69,800	66,900	181,000	432,000	700,000	395,000	168,000	107,000
24	89,200	78,600	71,400	61,300	69,000	67,600	199,000	441,000	697,000	385,000	168,000	106,000
25	91,000	77,800	69,800	66,200	68,300	70,600	226,000	457,000	682,000	374,000	168,000	105,000
26	92,000	79,400	69,800	68,300	67,600	69,000	254,000	493,000	677,000	359,000	170,000	103,000
27	92,000	79,400	64,800	68,300	68,300	70,600	264,000	522,000	668,000	349,000	169,000	105,000
28	92,000	82,000	66,900	69,800	68,300	73,800	278,000	551,000	664,000	340,000	169,000	107,000
29	90,100	79,400	64,800	70,600	.....	77,000	286,000	583,000	660,000	332,000	168,000	110,000
30	90,100	80,200	63,400	71,400	.....	80,200	276,000	611,000	651,000	322,000	166,000	110,000
31	92,000	.....	63,400	66,200	.....	90,100	.....	657,000	.....	308,000	163,000	.....

Monthly discharge of Columbia River at The Dalles, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 237,000 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	120,000	89,200	101,000	0.426	0.49	6,210,000
November	95,000	77,000	84,600	.357	.40	5,030,000
December	81,100	63,400	74,200	.313	.36	4,560,000
January	74,600	56,800	66,500	.281	.32	4,090,000
February	73,000	62,000	68,300	.288	.30	3,790,000
March	90,100	64,800	69,900	.295	.34	4,300,000
April	286,000	93,000	178,000	.751	.84	10,600,000
May	657,000	233,000	391,000	1.65	1.90	24,000,000
June	727,000	594,000	657,000	2.77	3.09	39,100,000
July	644,000	308,000	478,000	2.02	2.33	29,400,000
August	297,000	163,000	204,000	.861	.99	12,500,000
September	159,000	103,000	123,000	.519	.58	7,320,000
The year	727,000	56,800	210,000	.886	11.94	151,000,000

Digitized by Google

TRIBUTARIES OF COLUMBIA RIVER BELOW MOUTH OF SNAKE RIVER.

WALLA WALLA RIVER BASIN.

SOUTH FORK OF WALLA WALLA RIVER NEAR MILTON, OREG.

LOCATION.—In SE. ¼ sec. 9, T. 4 N., R. 37 E., a quarter of a mile above head gate of pipe line of Pacific Power & Light Co., and about 12 miles above Milton, Umatilla County.

DRAINAGE AREA.—72 square miles.

RECORDS AVAILABLE.—August 10 to September 15, 1906; January 1, 1907, to March 14, 1908; October 14, 1908, to November 24, 1917, when station was discontinued. For station at point 6 miles below present site, February 16, 1903, to May 29, 1906.

GAGE.—Vertical staff; read by R. Chapman. Datum of gage is 0.07 foot above that used up to September 30, 1914.

DISCHARGE MEASUREMENTS.—Made by wading near gage.

CHANNEL AND CONTROL.—Gravel and small boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.25 feet May 13 (discharge not determined); minimum stage recorded, 2.09 feet August to November (discharge, 108 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Station is above all diversions.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during flood of May, 1917. Rating curve for low water of 1917 defined by one measurement and form of previous curve. Gage read once a day to quarter-tenths. Daily discharge July to November ascertained by applying daily gage reading to rating table. Records fair. Discharge October to June, not determined.

The following discharge measurement was made by Reineman and Roeder, water masters:

October 8, 1917: Gage height, 2.09 feet; discharge, 108 second-feet.

Daily gage height, in feet, of South Fork of Walla Walla River near Milton, Oreg., for the period October, 1916, to June, 1917.

Day.	Oct.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.40	.....	2.45	2.50	2.45	2.66	3.18	.....
2	2.40	.....	2.46	2.48	2.45	2.70	3.11	.....
3	2.40	.....	2.48	2.49	2.45	2.70	3.15	.....
4	2.40	.....	2.49	2.58	2.45	2.80	3.12	.....
5	2.40	.....	2.55	2.68	2.45	3.28	3.19	.....
6	2.40	.....	2.62	2.71	2.45	3.40	3.28	.....
7	2.40	.....	2.65	2.70	2.45	3.66	3.40	.....
8	2.40	.....	2.65	2.70	2.45	4.02	3.75	.....
9	2.40	.....	2.65	2.70	2.46	3.45	3.99	.....
10	2.40	.....	2.62	2.70	2.48	3.29	4.08	3.49
11	2.40	.....	2.62	2.69	2.48	3.52	4.12	3.27
12	2.40	.....	2.58	2.70	2.48	3.22	4.26	3.17
13	2.40	3.20	2.55	2.66	2.48	3.10	4.30	3.17
14	2.40	2.78	2.52	2.62	2.48	3.10	.....	3.32
15	2.40	2.66	2.50	2.60	2.48	3.01	.....	3.67
16	2.40	2.64	2.48	2.72	2.45	2.90	.....	3.75
17	2.40	2.59	2.48	2.80	2.45	2.81	.....	3.62
18	2.40	2.55	2.45	2.76	2.46	2.78	.....	3.47
19	2.40	2.58	2.45	2.71	2.50	2.75	.....	3.37
20	2.40	2.60	2.45	2.68	2.50	2.82	.....	3.27
21	2.40	2.64	2.45	2.64	2.50	3.28	.....	3.19
22	2.40	2.59	2.45	2.58	2.50	3.34	.....	3.12
23	2.40	2.55	2.45	2.55	2.50	4.00	.....	3.09
24	2.40	2.52	2.45	2.51	2.54	3.75	.....	3.09
25	2.40	2.50	2.48	2.48	2.54	3.92	.....	2.99
26	2.40	2.50	2.48	2.48	2.50	4.25	.....	2.96
27	2.44	2.48	2.58	2.48	2.51	3.70	.....	2.93
28	2.41	2.48	2.66	2.48	2.59	3.50	.....	2.92
29	.....	2.45	2.61	.....	3.04	3.44	.....	2.91
30	.....	2.45	2.55	.....	2.88	3.30	.....	2.89
31	.....	2.45	2.52	.....	2.76	.....	.....	.....

Digitized by Google

Daily discharge, in second-feet, of South Fork of Walla Walla River near Milton, Oreg., for the period July 1 to Nov. 24, 1917.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1	299	124	108	108	108	16	163	117	108	108	112
2	275	122	108	108	108	17	158	117	108	108	112
3	257	120	108	108	112	18	152	117	108	108	112
4	245	120	108	108	112	19	152	114	108	108	108
5	239	120	108	108	108	20	145	112	108	108	108
6	230	120	108	108	108	21	140	112	108	108	108
7	221	120	108	108	112	22	140	112	108	108	108
8	215	120	108	108	112	23	136	112	111	108	108
9	202	117	108	108	112	24	136	112	111	108	108
10	193	117	108	108	112	25	130	112	112	108	.....
11	188	117	108	108	112	26	130	111	112	108	.....
12	188	117	108	108	112	27	128	108	112	108	.....
13	183	117	108	108	112	28	124	108	112	108	.....
14	176	117	108	108	112	29	124	108	111	108	.....
15	168	117	108	108	112	30	124	108	108	108	.....
						31	124	108	.....	108	.....

Monthly discharge of South Fork of Walla Walla River near Milton, Oreg., for the period July 1 to Nov. 24, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
July	299	124	177	10,900
August	124	108	115	7,070
September	112	108	109	6,490
October	108	108	108	6,640
November 1–24	112	108	110	5,240
The period	.....	.....	.....	36,300

MILL CREEK NEAR WALLA WALLA, WASH.

LOCATION.—In sec. 12, T. 6 N., R. 37 E., below diversion dam of Walla Walla water works and 12 miles east of Walla Walla, in Walla Walla County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 27, 1913, to September 30, 1917, when station was discontinued.

GAGE.—Vertical staff spiked to cottonwood tree on left bank 500 feet below diversion dam; read by Otto Zimmerman.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Control consists of long gravel bar and boulder riffle; shifting at high stages. Banks high and not subject to overflow. Stage of zero flow, according to measurements made August 17 and November 2, 1916, gage height 1.1 feet ±0.2 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.09 feet at 7 a. m. May 13 (discharge, 1,120 second-feet); minimum stage recorded, 1.75 feet October 22 and 23 and 2.32 feet August 29–31, September 1–6, 19–21, and 26–30 (discharge, 28 second-feet). Discharge October 1–21, 24–26, and 28 at gage height 1.76 feet, also 28 second-feet.

1913–1917: Maximum stage recorded May 13, 1917; minimum stage recorded, 0.69 foot August 29 to September 1, 1915 (discharge, 21 second-feet).

ICE.—Stage-discharge relation seriously affected by ice during severe winters; flow estimated from observer's notes and weather records.

Digitized by Google

DIVERSIONS.—The city of Walla Walla diverts from 21 to 32 second-feet of water above the station for public water supply. The quantity diverted was ascertained by deducting the flow measured at the station from that obtained by miscellaneous measurements (p. 142) above the intake.

REGULATION.—Gates at intake of water-supply conduit are closed occasionally when settling basins are cleaned.

ACCURACY.—Stage-discharge relation changed at high water on May 13; affected by ice December 30 and part of each day from January 16 to 18. Rating curve used prior to change well defined; curve used after the change fairly well defined up to 300 second-feet. Shifting-control method used May 14 to 18. Gage read twice daily to hundredths. Daily discharge ascertained by applying mean daily gage height to rating table. Records prior to high water in May excellent, after high water good.

COOPERATION.—Gage-height record furnished by city of Walla Walla.

Discharge measurements of Mill Creek near Walla Walla, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft*
Nov. 2	J. E. Stewart	1.79	28.6	June 30	John McCombs	2.72	103
Mar. 9	C. G. Paulsen	2.01	61	Sept. 15	C. G. Paulsen	2.35	32.1
Apr. 10	John McCombs	2.90	372				

Daily discharge, in second-feet, of Mill Creek near Walla Walla, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	28	30	46	40	53	44	117	422	269	101	34	28
2	28	31	50	59	52	43	112	397	247	98	34	28
3	28	34	73	85	70	43	105	372	247	93	34	28
4	28	33	100	100	98	48	152	397	230	91	33	28
5	28	36	73	223	175	56	450	422	222	88	33	28
6	28	38	66	223	240	54	450	477	239	88	33	28
7	28	36	54	143	210	54	450	532	264	106	33	30
8	28	33	52	117	182	56	810	652	301	103	33	30
9	28	39	50	110	149	61	477	744	346	88	33	30
10	28	37	44	117	125	59	422	777	296	70	33	30
11	28	33	44	117	117	56	450	912	234	68	32	40
12	28	30	94	98	117	56	372	1,020	195	64	32	34
13	28	30	257	88	112	56	308	1,090	199	62	32	38
14	28	30	128	73	94	56	280	982	256	58	32	31
15	28	30	94	63	198	53	231	912	264	54	32	32
16	28	29	73	58	215	53	182	562	311	52	31	31
17	28	29	66	48	160	54	140	397	273	49	31	31
18	28	30	79	46	140	63	131	322	230	48	31	31
19	28	30	108	46	125	66	122	264	207	46	31	28
20	28	30	98	44	108	66	134	273	199	44	30	28
21	28	29	83	43	88	59	397	264	188	43	30	28
22	28	30	73	42	70	56	397	260	156	41	30	30
23	28	30	66	40	66	50	912	247	163	40	30	51
24	28	30	59	39	66	59	622	247	144	40	30	33
25	28	47	56	47	63	59	532	230	131	37	30	31
26	28	63	50	44	56	56	1,060	239	125	38	30	28
27	32	98	47	81	50	66	947	282	125	37	30	28
28	28	79	44	83	47	94	712	371	125	37	30	28
29	37	54	43	73	.....	262	622	548	120	36	28	28
30	31	53	40	68	.....	210	504	426	106	36	28	28
31	39	.....	40	61	.....	146	.....	320	.....	36	28	.....

NOTE.—Stage-discharge relation affected by ice Dec. 30 (discharge estimated) and part of each day Jan. 16–18 (discharge ascertained from afternoon readings which were not affected by backwater from ice).

Digitized by Google

Monthly discharge of Mill Creek near Walla Walla, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	39	28	28.9	1,780
November	98	29	38.7	2,300
December	257	40	72.6	4,460
January	223	39	81.3	5,000
February	240	47	116	6,440
March	262	43	71.4	4,390
April	1,060	105	420	25,000
May	1,090	230	495	30,400
June	346	106	213	12,700
July	106	36	61.0	3,750
August	34	28	31.3	1,920
September	51	28	30.8	1,830
The year	1,090	28	138	100,000

UMATILLA RIVER BASIN.

UMATILLA RIVER ABOVE FURNISH RESERVOIR, NEAR YOAKUM, OREG.

LOCATION.—In NW. ¼ sec. 17, T. 2 N., R. 31 E., at Oregon-Washington Railroad & Navigation Co.'s bridge a quarter of a mile above Campbell flag station, 5 miles by river above Yoakum and old gaging station, and 10 miles west of Pendleton, Umatilla County; just above backwater from Furnish reservoir.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 18 to August 28, 1915; July 5, 1916, to September 30, 1917.

GAGE.—Stevens 8-day water-stage recorder on right side of main channel at downstream end of bridge pier; installed in July, 1916. Temporary gage near same site used in 1915. Observer, O. L. Dusschee.

DISCHARGE MEASUREMENTS.—Made from cable 20 feet above gage. Low-water measurements made by wading or from a log across river 200 feet above cable.

CHANNEL AND CONTROL.—Channel straight at bridge; current even; left bank high and rocky; right bank low with some cottonwood and brush; overflow channel extends under west span of bridge. Control is at almost right-angle turn to right, about 250 feet below gage and below deep pool, and is composed of gravel and free from vegetation; may shift slightly.

EXTREMES OF DISCHARGE.—1916–17: Maximum stage recorded during year, 9.03 feet at 2 p. m. May 13, 1917 (discharge, 7,940 second-feet); minimum stage recorded, 0.40 foot at 6 p. m. July 27, 1917 (discharge, 27 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—720 acres irrigated from Umatilla River above station and some from tributaries.

REGULATION.—At low stages water is ponded in the power canals of two flouring mills at Pendleton and released at intervals to obtain sufficient power for operating the mills. This causes a rapidly fluctuating stage at the station. There is practically no effect at medium and high stages. Backwater from the Furnish reservoir extends to within a few hundred yards of the control.

99664°—20—WSP 464——2

Digitized by Google

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 30 and 500 second-feet and fairly well defined above 500 second-feet. Operation of water-stage recorder satisfactory January 22 to June 7; unsatisfactory for certain periods during rest of year. (See footnote to table of daily discharge.) Daily discharge ascertained as follows: October 3 to 23, by use of discharge integrator; December 12, January 25, March 28, 29, and April 5, by averaging the values obtained by applying to rating table the gage heights for various subdivisions of the day; for all other days, except those given in footnote to table of daily discharge, by applying to rating table the mean daily gage height. Records good.

COOPERATION.—Station installed and records obtained under direction of L. A. Reineman, water master for Umatilla County.

Discharge measurements of Umatilla River above Furnish reservoir, near Yoakum, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 10	L. A. Reineman	6.73	4,570	July 23	L. A. Reineman	1.11	100
June 19	do	3.84	1,290	25	H. R. Wessel	1.02	79
July 2	Reineman and Wessel	2.23	356	27	do	.92	69
11	H. R. Wessel	1.56	191	Aug. 1	do	.83	60
12	do	1.49	168	3	L. A. Reineman	.78	54
13	do	1.44	154	7	H. R. Wessel	.65	43
14	Reineman and Wessel	1.41	163	28	L. A. Reineman	.46	30.9
16	H. R. Wessel	1.38	148				

Daily discharge, in second-feet, of Umatilla River above Furnish reservoir, near Yoakum, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	41	56	92	243	225	228	1,040	4,260	3,590	a 403	63	30
2	41	57	90	202	215	228	970	3,720	3,200	368	60	32
3	41	59	a 104	273	202	225	940	3,850	2,840	332	57	32
4	44	59	117	322	270	218	1,080	3,850	2,490	a 316	52	33
5	45	66	125	754	374	264	2,910	3,980	2,320	a 300	51	34
6	43	70	129	910	640	285	4,680	4,400	2,320	a 285	48	34
7	44	74	125	a 755	736	306	4,820	5,520	2,440	a 270	45	34
8	44	72	119	600	790	303	6,090	5,800	a 2,340	a 255	44	34
9	46	71	119	506	748	315	5,800	6,390	a 2,250	240	43	a 35
10	47	66	115	483	655	315	4,540	6,990	a 2,150	218	42	a 36
11	47	69	117	466	565	309	4,960	6,990	2,060	190	41	a 37
12	47	69	353	a 415	650	300	4,540	6,990	a 1,900	173	38	a 38
13	47	72	1,250	a 365	715	297	3,590	7,740	a 1,740	163	36	39
14	45	a 70	590	315	625	303	3,330	6,990	1,580	157	35	40
15	46	a 67	438	a 270	535	297	2,960	6,840	a 1,540	148	35	39
16	43	a 65	a 406	225	692	285	2,540	5,380	a 1,500	139	35	38
17	46	62	a 373	a 212	1,000	291	2,220	4,400	a 1,450	125	35	37
18	46	66	340	a 200	850	318	2,060	3,980	1,410	121	34	37
19	47	62	413	a 189	665	350	1,910	3,850	1,290	121	35	36
20	49	63	469	a 178	530	350	1,960	3,850	a 1,190	111	33	35
21	50	62	469	a 166	448	343	2,960	3,590	a 1,090	103	32	a 42
22	50	62	466	155	399	322	3,720	3,590	a 985	92	32	a 49
23	50	62	385	155	357	303	5,660	3,460	a 885	89	32	a 56
24	50	60	326	149	329	303	6,690	3,330	a 785	84	32	62
25	50	74	309	396	309	374	5,800	3,590	685	81	30	54
26	49	88	a 287	264	282	368	7,290	3,590	a 631	75	30	50
27	50	103	a 265	246	261	364	7,290	3,720	a 578	72	28	47
28	55	107	243	a 245	246	728	6,240	4,120	a 525	71	a 28	45
29	56	109	a 243	243	.....	1,780	5,380	4,680	472	67	a 29	45
30	56	99	a 243	a 241	.....	1,910	4,820	4,820	a 438	64	a 29	44
31	56	.....	a 243	240	.....	1,370	.....	4,120	.....	64	a 30	.....

a Interpolated because of unsatisfactory gage-height record.

Digitized by Google

Monthly discharge of Umatilla River above Furnish reservoir, near Yoakum, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	56	41	47.5	2,920
November	109	56	71.4	4,250
December	1,250	90	302	18,600
January	910	149	335	20,600
February	1,000	202	511	28,400
March	1,910	218	450	27,700
April	7,290	940	3,960	236,000
May	7,740	3,330	4,790	295,000
June	3,590	438	1,620	96,400
July	403	64	171	10,500
August	63	28	38.5	2,370
September	62	30	40.1	2,390
The year	7,740	28	1,030	745,000

UMATILLA RIVER NEAR UMATILLA, OREG.

LOCATION.—In NW. ¼ sec. 21, T. 5 N., R. 28 E., near main line of Oregon-Washington Railroad & Navigation Co., about a mile below diversion point of Oregon Land & Water Co.'s canal, and 1½ miles above Umatilla, Umatilla County, and mouth of river.

DRAINAGE AREA.—2,130 square miles.

RECORDS AVAILABLE.—October 21, 1903, to September 30, 1917.

GAGE.—Inclined staff in two sections; lower section 1.2 to 3.5 feet, upper 3.5 to 10.8 feet. Gage reader, T. J. George.

DISCHARGE MEASUREMENTS.—Made from cable or by wading.

CHANNEL AND CONTROL.—Solid rock without gravel or sand. One channel at all stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8 feet at 2 p. m. April 27 and at 8 a. m. May 14 (discharge, 10,200 second-feet); minimum stage recorded, 2.45 feet June 29 (discharge, 68 second-feet).

1903–1917: Maximum stage recorded, 11 feet May 31, 1906 (discharge, 19,600 second-feet); minimum stage recorded, 1 foot July 25 and August 1 to 9, 1906 (channel dry).

ICE.—Occasionally shore and floating ice, but stage-discharge relation not materially affected.

DIVERSIONS.—Large part of total flow of river diverted for irrigation above station. The Umatilla project feed canal also diverts water during the winter for storage in the Cold Springs reservoir. The low-water flow is return water from the Hermiston project and other irrigated tracts.

REGULATION.—Practically none.

ACCURACY.—Stage-discharge relation practically permanent for stages above 3.5 feet (discharge, 770 second-feet); below this a change in relation occurred in 1917. Rating curve well defined. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records good except for November and March, for which months they are derived from records of the station above Furnish reservoir.

COOPERATION.—Gage-height record furnished by a United States Reclamation Service.

No discharge measurements made during year.

Digitized by Google

Daily discharge, in second-feet, of Umatilla River near Umatilla, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	108	.....	.....	415	305	240	1,520	4,680	3,680	105	79	81
2	108	.....	.....	455	284	210	1,310	3,860	3,140	99	79	83
3	108	.....	.....	495	270	185	1,310	3,310	2,450	93	79	86
4	90	.....	216	538	210	.....	1,240	3,680	2,130	90	77	86
5	102	.....	216	580	210	.....	2,290	3,680	1,820	90	77	86
6	102	.....	.....	625	340	.....	4,460	3,860	1,660	90	77	86
7	96	.....	.....	670	720	.....	4,460	4,460	1,660	90	77	86
8	96	.....	.....	720	770	.....	5,370	6,060	1,820	83	79	86
9	96	.....	.....	770	880	.....	7,570	6,060	1,820	86	79	86
10	99	.....	.....	720	938	.....	5,370	6,540	1,890	86	81	86
11	102	.....	.....	670	880	.....	4,680	7,040	1,820	83	83	86
12	105	.....	.....	625	825	.....	5,830	7,570	1,520	83	83	88
13	108	.....	1,380	580	770	.....	4,260	8,140	1,120	83	83	88
14	111	.....	1,820	538	770	.....	3,490	9,590	995	83	81	86
15	108	.....	1,380	455	825	.....	3,490	7,850	880	83	81	86
16	111	.....	1,120	355	880	.....	3,310	7,300	995	83	79	86
17	114	.....	995	355	995	.....	2,620	4,680	995	81	81	86
18	120	.....	938	355	1,120	.....	2,290	3,680	938	81	83	83
19	128	.....	938	355	1,180	.....	2,130	3,310	825	81	83	79
20	128	.....	880	355	1,240	.....	1,970	3,140	495	79	83	75
21	132	.....	825	355	1,120	.....	2,130	2,960	495	79	83	72
22	120	.....	770	340	880	.....	3,490	2,790	415	79	83	81
23	120	.....	770	340	770	.....	4,260	2,620	415	81	83	81
24	120	.....	720	340	495	.....	7,300	2,620	270	83	83	81
25	120	.....	580	340	455	.....	6,790	2,790	185	88	83	81
26	124	.....	538	305	355	.....	6,790	2,960	140	90	83	81
27	124	200	880	270	312	.....	9,880	2,960	117	93	83	81
28	124	.....	415	305	298	.....	8,430	3,140	79	93	83	81
29	128	.....	385	340	.....	.....	6,540	3,490	68	86	83	81
30	128	.....	355	355	.....	.....	5,600	4,910	90	83	83	81
31	128	.....	385	415	.....	.....	.....	5,140	.....	79	81	.....

NOTE.—Discharge estimated at 130 second-feet Nov. 1-20; 170 second-feet, Nov. 21-26; 190 second-feet, Nov. 28-30; 200 second-feet Dec. 1-3; 210 second-feet Dec. 6-12; 250 second-feet Mar. 4-28; 1,400 second-feet Mar. 29-31.

Monthly discharge of Umatilla River near Umatilla, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).		
	Maximum.	Minimum.	Mean.	River.	Canals.	Total.
October	132	96	113	6,950	.....	6,950
November	.....	.....	146	8,690	.....	8,690
December	1,820	.....	599	36,800	.....	36,800
January	770	270	462	28,400	.....	28,400
February	1,240	210	682	37,900	.....	37,900
March	.....	.....	358	22,000	337	22,300
April	9,880	1,240	4,340	258,000	2,040	260,000
May	9,590	2,620	4,670	287,000	2,160	289,000
June	3,680	68	1,160	69,000	2,470	71,500
July	105	79	86.0	5,290	3,590	8,880
August	83	77	81.1	4,990	3,680	8,670
September	88	72	83.2	4,950	3,380	8,330
The year	9,880	68	1,060	770,000	17,700	787,000

NOTE.—Run-off given for canals is sum of run-off of West Umatilla and irrigation canals which divert around the station. Record of total run-off furnished by United States Reclamation Service.

Digitized by Google

JOHN DAY RIVER BASIN.

JOHN DAY RIVER NEAR PRAIRIE CITY, OREG.

LOCATION.—In SW. ¼ NE. ¼ sec. 10, T. 13 S., R. 33 E., one-eighth mile below Prairie Power Co.'s plant and about a mile from center of Prairie City, Grant County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 30, 1916, to September 30, 1917, when station was discontinued.

GAGE.—Vertical staff on left bank; read by E. T. Schroeder.

DISCHARGE MEASUREMENTS.—Made by wading. No equipment for making high-water measurements.

CHANNEL AND CONTROL.—Gravel; shifts in extreme floods.

EXTREMES OF STAGE.—Maximum stage recorded during period, 3.90 feet at 6.30 p. m. April 8. Minimum stage recorded, 0.16 foot at 7.30 a. m. January 12, 13, and 14.

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—A considerable part of the summer flow is diverted above the station for irrigation.

REGULATION.—Practically none. Power canal diverts a constant amount and spills into river near plant when not using all the water through the wheels.

ACCURACY.—Stage-discharge relation not permanent. Sufficient measurements to develop rating curve not obtained. Gage read twice daily to hundredths. Daily discharge not determined.

Discharge measurements of John Day River near Prairie City, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 30	C. L. Batchelder	0.50	85
July 28	R. C. Briggs	.96	98

Daily gage height, in feet, of John Day River near Prairie City, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	0.50	0.54	0.49	0.22	0.24	0.77	1.89	2.53	1.74	0.94	.....
2	.....	.53	.53	.62	.46	.26	.85	1.77	2.42	1.66	.92	0.48
3	.....	.48	.55	.54	.55	.54	.83	1.78	2.36	1.56	.92	.50
4	.....	.48	.52	.55	.43	.55	1.35	1.89	2.20	1.54	.91	.52
5	.....	.54	.52	.55	.46	.49	2.04	1.94	2.10	1.60	.89	.53
6	.....	.53	.51	.51	.41	.50	2.33	2.07	1.98	1.46	.87	.56
7	.....	.57	.48	.50	.40	.44	3.03	2.40	2.07	1.35	.84	.59
8	.....	.51	.47	.47	.40	.49	3.49	2.49	2.21	1.36	.81	.55
9	.....	.51	.53	.50	.38	.47	2.74	2.63	2.58	1.31	.79	.57
10	.....	.51	.52	.45	.39	.49	2.75	2.66	2.67	1.24	.81	.57
11	.....	.38	.46	.49	.42	.48	3.50	2.78	2.58	1.14	.80	.61
12	.....	.30	.56	.24	.45	.49	2.43	2.93	2.27	1.08	.75	.61
13	.....	.21	.58	.23	.46	.47	2.09	3.11	2.06	.96	.75	.69
14	.....	.41	.47	.18	.41	.45	1.99	3.21	1.90	.94	.73	.73
15	.....	.51	.46	.20	.39	.46	1.65	3.27	1.98	.92	.69	.75
16	.....	.49	.56	.19	.48	.46	1.65	2.90	2.27	.87	.67	.73
17	.....	.51	.54	.22	.48	.39	1.58	2.65	2.64	.87	.72	.73
18	.....	.53	.52	.27	.48	.44	1.74	2.37	2.71	.84	.63	.73
19	.....	.54	.52	.43	.46	.46	1.57	2.23	2.56	.86	.52	.71
20	.....	.48	.47	.50	.47	.47	1.58	2.19	2.45	.87	.55	.71
21	.....	.47	.49	.48	.44	.47	1.95	2.11	2.41	.86	.43	.71
22	.....	.49	.45	.45	.42	.46	1.98	2.04	2.28	.81	.49	.71
23	.....	.52	.49	.46	.45	.48	2.36	1.98	2.19	.83	.54	.96
24	.....	.49	.47	.51	.47	.52	2.30	2.30	2.12	.83	.40	1.01
25	.....	.54	.43	.48	.61	.50	2.76	2.30	2.05	.84	.40	.89
26	.....	.60	.43	.44	.53	.47	3.01	2.30	1.96	.92	.....	.90
27	.....	.52	.25	.48	.50	.54	2.63	2.30	1.91	.96	.....	.87
28	.....	.56	.42	.46	.49	.68	2.29	2.43	1.90	.95	.....	.89
29	.....	.51	.56	.44	.....	.98	2.04	2.74	1.87	.94	.....	.86
30	0.50	.54	.30	.39	.....	.78	1.92	2.82	1.83	.94	.....	.84
31	.50	.....	.46	.35	.....	.76	.....	2.67	.....	.95	.48	.....

Digitized by Google

JOHN DAY RIVER AT McDONALD, OREG.

LOCATION.—In NW. ¼ sec. 11, T. 1 N., R. 19 E., at ferry at McDonald post office, Sherman County, half a mile below mouth of Rock Creek, 16 miles above junction with Columbia River, and 18 miles southwest of Arlington.

DRAINAGE AREA.—7,800 square miles.

RECORDS AVAILABLE.—December 16, 1904, to September 30, 1917.

GAGE.—Inclined staff in two sections on left bank, 183 feet above ferry cable; read by William G. McDonald.

DISCHARGE MEASUREMENTS.—Made from cable or by wading.

CHANNEL AND CONTROL.—Clean gravel and sand; shifts slightly. Banks high. One channel at all stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.6 feet at 1 p. m., April 27 (discharge, 22,600 second-feet); minimum stage recorded, 1.35 feet September 4 to 10 and 12 to 15 (discharge 150 second-feet).

1905–1917: Maximum stage recorded, 10.38 feet February 6, 1907 (discharge, 22,800 second-feet). A flood about 20 years ago is said to have reached a height of 12.8 feet (discharge estimated from extension of rating curve as 33,000 second-feet). Minimum stage recorded, 1.02 feet September 8 to 11, 1915 (discharge, 63 second-feet).

ICE.—Stage-discharge relation affected by ice for short periods.

DIVERSIONS.—Large part of natural low-water flow of stream diverted in the upper John Day Valley for irrigation.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during high water of April 27. Rating curve, used October 1 to April 26, well defined between 80 and 6,000 second-feet. That used April 27 to September 30, well defined between 250 and 10,000 second-feet. Both curves fairly well defined outside of these limits. Gage read to quarter-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Gage heights uncertain July 13 to 19 and discharge interpolated. Records good.

Discharge measurements of John Day River at McDonald, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
May 24	C. L. Batchelder	6.11	9,020
Aug. 6	R. C. Briggs	1.76	371

Digitized by Google

Daily discharge, in second-feet, of John Day River at McDonald, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	310	461	648	431	780	970	3,160	11,900	13,000	3,420	468	166
2	310	477	605	735	648	970	2,630	10,900	11,600	3,200	438	162
3	310	485	605	565	605	870	2,800	10,200	10,500	3,000	438	162
4	310	509	605	690	648	780	2,630	9,880	9,560	2,810	400	150
5	310	485	648	735	780	870	2,980	10,500	7,360	2,810	372	150
6	310	493	565	690	780	920	7,260	10,900	7,060	2,460	365	150
7	336	509	565	735	870	1,070	10,000	11,900	7,360	2,460	344	150
8	375	509	605	735	780	1,020	11,300	15,400	7,660	2,300	330	150
9	375	525	525	735	735	970	16,800	15,800	8,600	2,140	330	150
10	389	605	485	690	690	870	14,400	16,400	10,200	1,990	318	150
11	375	565	477	648	780	970	12,000	17,200	9,880	1,840	306	162
12	389	565	517	565	825	970	14,000	18,400	8,600	1,640	300	150
13	389	605	493	461	870	920	13,000	19,200	7,360	1,550	282	150
14	389	605	485	410	870	870	10,000	20,800	6,180	1,460	270	150
15	389	485	461	362	920	870	9,380	20,400	5,620	1,370	270	150
16	389	431	690	389	870	870	8,440	20,000	6,180	1,270	259	162
17	382	342	525	262	970	870	6,980	16,100	7,360	1,180	259	162
18	375	461	477	648	920	870	6,420	13,300	8,280	1,090	248	162
19	375	461	509	735	870	870	5,860	12,600	8,280	1,000	242	170
20	375	565	605	690	920	870	6,420	10,500	7,360	910	226	192
21	375	565	605	605	920	920	6,700	10,200	6,760	820	226	206
22	375	509	605	509	870	970	10,300	9,880	6,180	820	226	206
23	375	485	648	525	870	1,020	12,700	9,240	5,900	730	226	206
24	389	525	605	605	870	1,070	16,100	8,920	5,360	640	220	206
25	389	565	565	605	870	1,120	16,800	9,880	5,100	640	242	215
26	389	525	525	605	780	1,270	16,800	10,500	4,840	598	210	226
27	403	565	525	648	1,380	1,670	20,800	10,200	4,580	555	192	259
28	410	605	525	690	1,220	2,630	20,000	9,880	4,100	547	188	555
29	417	605	461	648	.....	3,160	16,400	10,900	3,860	523	179	415
30	445	690	445	690	.....	6,980	13,600	12,600	3,640	507	174	400
31	453	.....	410	780	.....	3,160	.....	14,000	.....	475	170	.....

NOTE.—Stage-discharge relation somewhat affected by ice Dec. 27 to Jan. 3 and Jan. 14-19; in determining discharge for these periods a slight correction was made to gage heights before entering rating table.

Monthly discharge of John Day River at McDonald, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	453	310	374	23,000
November	690	342	526	31,300
December	690	410	549	33,800
January	780	262	607	37,300
February	1,380	605	854	47,400
March	6,980	780	1,360	83,600
April	20,800	2,630	10,600	631,000
May	20,800	8,920	13,200	812,000
June	13,000	3,640	7,280	433,000
July	3,420	475	1,510	92,800
August	468	170	281	17,300
September	555	150	201	12,000
The year	20,800	150	3,110	2,250,000

STRAWBERRY CREEK NEAR PRAIRIE CITY, OREG.

LOCATION.—In sec. 5, T. 14 S., R. 34 E., at Nelson's ranch, about 6 miles south of Prairie City, Grant County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 5, 1916, to September 30, 1917, when station was discontinued.

Digitized by Google

GAGE.—Vertical staff on downstream side of wagon bridge. Gage reader, Wm. G. Nelson.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Gravel and boulders; practically permanent.

EXTREMES OF STAGE.—Maximum stage recorded during period, 5.62 feet June 17, 1917. Minimum stage, 4.20 feet most of time, February 5 to April 3.

ICE.—Stream freezes almost solid during severe winter weather.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Not sufficient measurements to develop rating curve. Gage read once daily to hundredths, November to June, and twice a week, July to September. Daily discharge not determined.

Discharge measurements of Strawberry Creek near Prairie City, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by-	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 31	C. L. Batchelder	4.30	6.6
July 29	R. C. Briggs	4.67	20.5

Daily gage height, in feet, of Strawberry Creek near Prairie City, Oreg., for the year ending Sept. 30, 1917.

Day.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1		4.30	4.28	4.22	4.20	4.20	4.48	5.20			4.45
2		4.30	4.60	4.22	4.20	4.20	4.48	5.22			4.45
3		4.30	4.25	4.22	4.20	4.20	4.42	5.22			
4		4.30	4.25	4.22	4.20	4.22	4.40	5.20			4.45
5	4.30	4.30	4.28	4.20	4.20	4.28	4.46	5.22		4.55	4.45
6	4.30	4.30	4.25	4.20	4.20	4.30	4.60	5.22			
7	4.30	4.28	4.25	4.20	4.20	4.35	4.80	5.28			4.45
8	4.30	4.28	4.28	4.20	4.20	4.38	4.90	5.35			
9	4.30	4.30	4.25	4.20	4.20	4.35	4.98	5.38			
10	4.30	4.30	4.25	4.20	4.20	4.38	5.00	5.30			4.45
11	4.30	4.30	4.25	4.20	4.20	4.38	5.10	5.28			
12	4.30	4.28	4.25	4.20	4.20	4.40	5.10	5.42		4.50	
13		4.25	4.50	4.20	4.20	4.35	5.15	5.40			4.45
14		4.28	4.25	4.20	4.20	4.35	5.00	5.45			
15		4.30		4.20	4.20	4.32	4.98	5.45			
16		4.30		4.20	4.20	4.35	4.92	5.60		4.48	4.45
17		4.30		4.20	4.20	4.40	4.95	5.62			
18	4.28	4.28		4.20	4.20	4.38	4.90	5.55			
19	4.28	4.28		4.20	4.20	4.40	4.90	5.58		4.48	
20	4.28	4.25	4.22	4.20	4.20	4.45	4.88	5.50			4.42
21	4.30	4.25	4.22	4.20	4.20	4.50	4.80	5.45	4.88		
22	4.30	4.28	4.22	4.20	4.20	4.55	4.75	5.48		4.48	
23	4.30	4.28	4.25	4.20	4.20	4.50	4.85	5.45			4.42
24	4.30	4.30	4.25	4.25	4.20	4.60	4.85	5.48			4.45
25	4.30	4.28	4.22	4.25	4.20	4.62	4.90	5.45			
26	4.30	4.28	4.22	4.20	4.20	4.55	4.92	5.45		4.48	4.42
27	4.30	4.28	4.22	4.20	4.20	4.48	5.02	5.40			
28	4.30	4.30	4.22	4.20	4.25	4.45	5.10	5.38		4.48	
29	4.30	4.30	4.22		4.20	4.45	5.12	5.35		4.48	
30	4.30	4.30	4.22		4.20	4.50	5.22	5.35	4.68		4.40
31		4.30	4.22		4.20		5.25				

Digitized by Google

DESOLATION CREEK NEAR DALE, OREG.

LOCATION.—In sec. 1, T. 7 S., R. 31 E., at Dale ranger station, in Grant County, one-fourth mile above junction with North Fork of John Day River, 1 mile from Dale, and about 12 miles south of Ukiah.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 21, 1915, to September 2, 1917, when station was discontinued.

GAGE.—Vertical staff on left bank. Gage reader, Chas. F. Groom, ranger, U. S. Forest Service.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Gravel and boulders; practically permanent.

EXTREMES OF STAGE.—Maximum stage recorded during year, 4.0 feet or slightly more during night of May 13; minimum stage recorded, 0.40 foot October 18, 19, 21 to 24, and August 25.

1915–1917: Maximum stage is that of 1917; minimum stage, 0.35 foot August 22, 23, September 1 to 4, and September 11, 1915.

ICE.—Stage-discharge relation affected during severely cold weather; record suspended during this period.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Measurements insufficient to develop rating curve. Gage read to quarter-tenths once daily when observer is at home. Daily discharge not determined.

Discharge measurements of Desolation Creek near Dale, Oreg., from July 21, 1915, to Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
July 21, 1915	H. M. Nelson	0.60	26.2
Nov. 1, 1916	C. L. Batchelder	.48	12.5
Aug. 2, 1917	R. C. Briggs	.70	27.3

Daily gage height, in feet, of Desolation Creek near Dale, Oreg., for the years ending Sept. 30, 1915 to 1917.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1915.				1915.				1915.			
1			0.35	11			0.35	21	0.60	0.40	
2		0.52	.35	12			.40	22		.35	
3		.50	.35	13				23		.35	
4		.50	.35	14				24			
5		.50		15				25			
6				16		0.45		26			
7				17				27			
8				18				28			
9				19				29			
10				20				30			
								31			

Digitized by Google

Daily gage height, in feet, of Desolation Creek near Dale, Oreg., for the years ending Sept. 30, 1915 to 1917—Continued.

Day.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915–16.											
1					0.78	1.50		1.90	1.45	0.70	0.50
2			0.50			1.50		1.85	1.60	.68	.50
3			.55					2.00		.65	.48
4		0.65	.60			1.50		2.10		.62	.48
5			.60			1.45		2.20		.60	.45
6		.42				1.45	2.50			.60	.45
7					.85	1.50	2.30		1.45	.58	.42
8					.90	1.65	2.20		1.45		.45
9					1.00	1.75	2.10		1.45		
10					1.15	2.00	1.90		1.30		
11					1.30	2.20	1.75		1.25		
12			.60			1.85			1.20		.50
13			.60			1.75			1.20	.55	
14	0.40		.55		1.20	1.80			1.15	.55	
15	.40					1.85			1.10	.52	.48
16	.45					1.92			1.07	.55	.45
17	.45					1.95			1.07	.58	
18				0.98		1.80	1.85	2.30	1.05	.60	
19				.95		1.68	2.35	2.20	1.05	.58	
20		.60		.95		1.60	2.25	1.85	1.00	.55	
21		.60		.95		1.65	2.15	1.70	.95		
22	.40	.55		.95			2.10	1.70	.92		
23				.90		1.50	1.95	1.65	.90		
24				.90		1.80		1.58	.88		
25		.52		.85		2.05		1.60	.85		.48
26	.40	.52		.80	1.30	2.30		1.70	.80		.45
27		.50		.80	1.35	2.45			.80		.45
28				.80	1.30	2.50			.78		.45
29	.40	.60		.78	1.25	2.10			.75		.45
30	.40	.60			1.01			1.50	.72		.42
31					1.15		1.85		.70		

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1916–17.								
1	0.42	0.50		1.30	2.45	1.80	0.50	0.50
2	.45	.48		1.28	2.40	1.85		.50
3	.47	.48		1.30				
4	.47	.50		1.42				
5	.47	.50		1.42				
6	.47	.50	1.00			1.60		
7	.45	.50	1.10	2.10		1.55		
8	.45	.50	1.25	2.30		1.50		
9	.45	.50	1.12	2.45		1.45		
10	.45	.50	1.05	2.52			.55	
11	.45		1.20	2.60			.60	
12	.45		1.10	2.70			.55	
13	.45		1.08	3.30	2.30		.60	
14	.45		1.10	3.50	2.50		.60	
15	.45			2.90	2.70			
16	.42		.90	2.60	2.90			
17	.42		.80	2.40	3.00			
18	.40		.80	2.30	2.90			
19	.40		.70		2.60			
20	.42		.75		2.50			
21	.40		1.01		2.50			
22	.40		1.30		2.40		.45	
23	.40		1.40		2.35		.45	
24	.40		1.50		2.25		.45	
25	.42		1.75	2.30	2.20	.85	.40	
26	.45		1.80		2.20	.80	.45	
27	.45		1.70		2.15	.75	.50	
28	.45		1.45	2.90	2.15	.70	.50	
29	.45		1.50	3.10	2.15	.60	.55	
30			1.30	2.70	2.15	.57	.50	
31	.45			2.50		.55	.50	

Digitized by Google

CAMAS CREEK ABOVE CABLE CREEK, NEAR UKIAH, OREG.

LOCATION.—In SE. ¼ sec. 4, T. 5 S., R. 32 E., at highway bridge 200 feet above mouth of Cable Creek and 6 miles east of Ukiah, Umatilla County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1914, to September 30, 1917, when station was discontinued.

GAGE.—Vertical staff on abutment of highway bridge; read by S. M. Ledgerwood.

DISCHARGE MEASUREMENTS.—Made from highway bridge or by wading.

CHANNEL AND CONTROL.—Rock and gravel; slightly shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.5 feet May 13 and 14 (discharge not determined); minimum stage recorded, 0.75 foot during October. Minimum discharge probably occurred during winter and was very small.

1914–1917: Maximum stage recorded was that of 1917. Minimum stage recorded, 0.50 foot August 29 to 31, 1914 (discharge, 3 second-feet). Discharge estimated to have become as low as 2 second-feet in December, 1914.

ICE.—Stream freezes almost solid during severe winter weather.

DIVERSIONS.—Practically none.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during year. Rating curve not developed. Gage read to quarter-tenths once daily except during floods, when two readings daily were made. Daily discharge not determined.

Discharge measurements of Camas Creek above Cable Creek, near Ukiah, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 1	C. L. Batchelder	0.80	5.4
Aug. 3	R. C. Briggs	.94	4.5

Daily gage height, in feet, of Camas Creek above Cable Creek, near Ukiah, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.75	0.82	1.40	1.80	2.10	2.60	1.0	3.0	3.0	1.3	1.0	0.98
2	.75	.80	1.40	2.05	2.10	2.60	1.5	2.9	2.9	1.5	.95	.96
3	.75	.82	1.40	2.10	1.80	2.70	1.5	3.2	2.8	1.5	.95	.96
4	.75	.80	1.40	2.50	1.70	3.50	1.4	3.4	2.8	1.4	.96	.96
5	.75	.88	1.30	2.10	1.40	3.60	1.9	3.3	2.6	1.4	.94	.96
6	.78	.88	1.10	2.05	2.40	3.20	2.2	3.65	2.6	1.3	.94	.96
7	.75	.88	1.20	2.02	2.30	2.80	2.45	4.0	2.8	1.3	.94	.96
8	.78	.85	.80	1.80	2.00	2.80	3.1	3.9	2.9	1.3	.94	.90
9	.75	.85	1.70	1.80	2.50	3.00	2.8	4.0	3.1	1.3	.96	.90
10	.75	.82	1.50	1.40	2.80	2.90	2.5	4.05	2.9	1.3	.92	.98
11	.75	.90	1.60	1.30	2.80	2.60	3.0	4.02	2.6	1.3	.92	.98
12	.75	.80	1.70	1.90	2.75	2.60	2.8	4.05	2.4	1.2	.90	.90
13	.75	.90	1.90	2.00	2.75	2.60	2.5	4.35	2.3	1.2	.90	.90
14	.75	1.00	1.30	2.20	1.80	2.00	2.55	4.40	2.3	1.15	.90	.90
15	.78	.90	1.80	1.70	2.50	2.50	2.2	3.90	2.8	1.1	.90	.94
16	.78	1.10	1.90	2.40	3.00	1.60	2.0	3.50	2.8	1.1	.90	.94
17	.75	1.10	1.75	.....	3.00	1.60	2.0	3.2	2.7	1.1	.90	.94
18	.75	1.20	1.72	.....	1.90	2.30	1.95	3.2	2.5	1.1	1.0	.90
19	.75	1.20	1.80	.....	3.10	3.35	1.9	3.2	2.3	1.1	.98	.90
20	.75	1.30	1.80	.....	3.00	2.50	2.2	2.9	2.3	1.1	.98	.90
21	.78	1.20	1.80	.....	3.00	2.50	2.8	2.9	2.3	1.1	.96	.98
22	.78	1.30	1.65	.....	2.90	2.40	3.4	2.9	2.0	1.0	.90	.90
23	.78	1.30	1.75	.....	2.90	2.45	3.85	2.9	2.0	1.0	.95	.98
24	.80	1.40	1.50	.....	2.65	2.40	3.7	3.1	1.95	1.0	.90	1.20
25	.78	1.35	1.90	.....	3.20	2.50	3.85	3.2	1.90	1.0	.90	1.96
26	.78	1.40	1.75	.....	3.00	1.50	4.0	3.2	1.85	1.0	.98	1.10
27	.75	1.40	1.70	.....	3.00	2.50	3.85	3.1	1.30	1.0	.98	1.0
28	.80	1.45	2.00	2.40	3.20	2.40	3.6	3.2	1.30	1.0	.98	.98
29	.80	1.45	1.70	2.40	.....	3.20	3.3	3.35	1.30	1.0	.98	.96
30	.82	1.40	1.50	2.40	.....	3.20	3.2	3.4	1.30	1.0	.98	.96
31	.82	.....	2.02	2.10	.....	3.00	.....	3.2	.....	1.0	.98	.....

NOTE.—Stage-discharge relation affected by ice Nov. 12 to Mar. 30.

Digitized by Google

CABLE CREEK NEAR UKIAH, OREG.

LOCATION.—In NE. ¼ sec. 9, T. 5 S., R. 32 E., at highway bridge about 1,000 feet above mouth of creek, about 6 miles east of Ukiah, Umatilla County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1914, to September 30, 1917, when station was discontinued.

GAGE.—Vertical staff on abutment of bridge; read by S. M. Ledgerwood.

DISCHARGE MEASUREMENTS.—Made from highway bridge or by wading.

CHANNEL AND CONTROL.—Gravel and rock; uneven; slightly shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.7 feet at 8 a. m. May 15 (discharge not determined); minimum discharge probably occurred during winter when the flow was probably zero.

1914–1917: Maximum and minimum stages are those of 1917.

ICE.—Stream freezes and may go almost dry in extremely cold weather.

DIVERSIONS.—Probably none.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during year. Rating curve not developed. Gage read to quarter-tenths once daily. Daily discharge not determined

Discharge measurements of Cable Creek near Ukiah, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 1	C. L. Batchelder	0.20	1.6
Aug. 3	R. C. Briggs	.07	3.0

Daily gage height, in feet, of Cable Creek near Ukiah, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.18	0.22	0.40	0.22	0.20	1.40	2.00	1.10	1.90	0.45	0.12	0.00
2	.18	.20	.40	.25	.20	1.80	1.50	1.20	1.80	.40	.09	.00
3	.18	.20	.40	.25	.30	2.00	.50	1.20	1.60	.30	.07	.00
4	.18	.20	.40	.25	.30	1.30	.40	1.30	1.50	.30	.08	.00
5	.18	.28	.35	.25	.30	1.05	1.20	1.30	1.45	.40	.08	.00
6	.20	.22	.20	.30	.30	.60	1.40	1.50	1.50	.30	.10	.00
7	.18	.22	.20	.35	.30	.40	1.50	1.70	1.60	.30	.08	.00
8	.18	.18	.30	.30	.20	.30	1.80	1.75	1.62	.35	.08	.00
9	.18	.20	.20	.30	.20	.30	1.35	1.90	1.80	.40	.08	.00
10	.18	.25	.25	.20	.20	.40	1.10	2.02	1.60	.30	.06	.00
11	.15	.20	.20	.30	.30	.32	1.50	2.12	1.50	.30	.06	.02
12	.15	.20	.20	.30	.30	.35	1.10	2.25	1.30	.28	.06	.04
13	.15	.30	.45	.50	.30	.40	1.00	2.52	1.30	.28	.04	.04
14	.15	.30	.30	.50	.30	.38	1.00	2.62	1.30	.25	.04	.04
15	.18	.10	.30	.10	.30	.30	.90	2.60	1.30	.25	.04	.04
16	.12	.10	.30	.....	.30	.30	1.00	2.20	1.30	.25	.04	.04
17	.15	.10	.30	.....	.30	.30	.75	1.90	1.20	.25	.04	.04
18	.15	.30	.25	1.0	.30	.30	.70	1.70	1.10	.20	.10	.04
19	.15	.50	.25	.....	.30	.30	.70	1.60	1.00	.20	.06	.02
20	.15	.70	.25	.....	.40	.35	.90	1.60	1.00	.20	.04	.02
21	.18	.50	.30	.....	.40	.40	1.30	1.60	.90	.20	.04	.02
22	.15	.50	.25	.....	.30	.30	1.70	1.55	.80	.30	.04	.00
23	.15	.50	.25	.....	.30	.35	1.80	1.55	.80	.25	.04	.18
24	.18	.50	.25	.....	.30	.38	1.60	1.70	.80	.25	.02	.26
25	.18	.50	.20	.....	.30	.40	1.82	1.72	.70	.25	.02	.26
26	.18	.60	.20	.....	.40	.30	1.70	1.68	.55	.22	.00	.10
27	.15	.60	.20	.....	.40	.35	1.65	1.70	.40	.22	.00	.04
28	.18	.70	.20	.30	.50	.45	1.40	1.90	.50	.20	.00	.06
29	.20	.65	.20	.40	.....	1.20	1.35	2.25	.50	.20	.00	.06
30	.22	.50	.20	.40	.....	1.60	1.20	2.20	.40	.18	.00	.06
31	.20	.....	.20	.30	.....	2.70	.....	2.00	.....	.15	.00	.....

NOTE.—Stage-discharge relation affected by ice from Nov. 12 to Mar. 31.

Digitized by Google

DESCHUTES RIVER BASIN.

DESCHUTES RIVER AT CRANE PRAIRIE, NEAR LAPINE, OREG.

LOCATION.—In sec. 17, T. 21 S., R. 8 E., at outlet of Crane Prairie, above proposed dam site and below mouth of Cultus River; about 28 miles by road west of Lapine, Deschutes County.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—January 1, 1914, to June 30, 1917, when station was discontinued; fragmentary gage readings 1907 to 1913.

GAGE.—Vertical staff on left bank at outlet of marsh; read by George E. Graft.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; somewhat shifting. Control some distance below station; rocky and fairly permanent. Stage-discharge relation slightly affected by growth of aquatic plants.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.8 feet, June 26 (discharge, 505 second-feet). Minimum stage recorded, 1.12 feet, March 31 (discharge 130 second-feet).

1907–1917: Maximum stage from fragmentary records, 2.75 feet July 31, 1913 (determined from high-water marks on Sept. 15); discharge, 531 second-feet. Minimum stage recorded in 1917.

ICE.—Ice jams may affect the stage-discharge relation during extremely cold weather.

DIVERSION.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent; affected by snow and ice December to January 20. Deschutes River at Crane Prairie near Lapine, Oreg. Rating curve fairly well defined. Gage read to quarter-tenths once weekly. Discharge ascertained by applying gage heights to rating table. Records fair.

Discharge measurements of Deschutes River at Crane Prairie, near Lapine, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 16	Batchelder and Reineking	2.41	422
June 3	Briggs and Batchelder	2.33	370
Aug. 20	R. C. Briggs	2.36	431

Digitized by Google

Daily discharge, in second-feet, of Deschutes River at Crane Prairie, near Lapine, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1									
2			330						
3					210	160			380
4		405							
5									
6									
7								355	
8									
9	430		300						455
10					190	160	200		
11		355							
12									
13									
14		355							
15								330	
16	405		310						455
17					180	142			
18		330					230		
19									
20				278					480
21									
22								290	
23									
24	405	310			170	145	265		
25									
26				240					505
27									
28									
29									
30							242	355	
31	380		310			130			

Monthly discharge of Deschutes River at Crane Prairie, near Lapine, Oreg., for the year ending Sept. 30, 1917.

Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).	Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).
October	405	24,900	March	147	9,040
November	351	20,900	April	234	13,900
December	312	19,200	May	332	20,400
January	276	17,000	June	455	27,100
February	188	10,400	The period		163,000

NOTE.—Monthly mean discharge is average of discharge determined for days on which gage was read.

DESCHUTES RIVER NEAR LAPINE, OREG.

LOCATION.—In NW. ¼ sec. 26, T. 20 S., R. 10 E., at Forest Service bridge at Big River ranger station, 7 miles by river above mouth of East Fork, 11 miles north of Lapine, Deschutes County.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—September 22 to December 21, 1910; February 18 to December 31, 1912; April 7 to October 27, 1913, occasional readings; October 1, 1914, to May 14, 1917, when station was discontinued.

GAGE.—Vertical staff on bent of bridge; read by Burton Oney.

DISCHARGE MEASUREMENTS.—Made from upstream side of wagon bridge. Conditions excellent.

CHANNEL AND CONTROL.—Stream bed composed of gravel and sand; no defined control. Channel crooked, apparently permanent; gradient low.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.12 feet October 1 to 5 (discharge, 1,200 second-feet); minimum stage recorded, 0.78 foot March 31 to April 14 (discharge, 865 second-feet).

1905–1917: [Extremes from record on Deschutes River near Lava, Oreg.] Maximum stage recorded, 11.50 feet November 26, 1909 (discharge, 1,700 second-feet); minimum stage recorded, 7.18 feet at time of measurement, November 8, 1911 (discharge, 739 second-feet).

ICE.—Stage-discharge relation materially affected by ice jams for short periods of extremely cold weather.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice for short periods during the winter. Rating curve well defined. Gage read to hundredths once daily when ranger is at station. Daily discharge ascertained by applying daily gage height to rating table. Records excellent for days when gage was read.

COOPERATION.—Gage readings furnished by United States Forest Service, W. G. Hastings, supervisor.

Discharge measurements of Deschutes River near Lapine, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 14	Batchelder and Reineking	2.00	1,190
June 4	Briggs and Batchelder	1.80	1,110

Daily discharge, in second-feet, of Deschutes River near Lapine, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	1,190	1,160	1,090	1,040	915	915	865	965
2	1,190	1,160	1,090	1,040	915	915	865	965
3	1,190	1,160	1,090	1,040	915	915	865	965
4	1,190	1,160	1,090	1,040	915	915	865	990
5	1,190	1,160	1,060	1,040	915	915	865	1,040
6	1,190	1,160	1,060	1,040	915	915	865	1,040
7	1,180	1,160	1,060	1,040	915	915	865	1,060
8	1,180	1,160	1,060	1,040	915	915	865	1,060
9	1,180	1,160	1,060	1,040	915	915	865	1,090
10	1,170	1,160	1,040	1,040	915	915	865	1,090
11	1,170	1,160	1,040	1,040	915	915	865	1,120
12	1,170	1,160	1,040	1,040	915	890	865	1,140
13	1,160	1,160	1,040	1,040	915	890	865	1,140
14	1,160	1,160	1,040	1,030	915	890	865	1,160
15	1,160	1,160	1,040	1,030	915	890	865	.....
16	1,160	1,160	1,040	1,030	915	890	865	.....
17	1,160	1,160	1,040	1,020	915	890	865	.....
18	1,160	1,160	1,040	1,020	915	890	865	.....
19	1,160	1,160	1,040	1,020	915	890	865	.....
20	1,160	1,160	1,040	1,020	915	890	865	.....
21	1,160	1,160	1,040	1,020	915	865	865	.....
22	1,160	1,150	1,040	1,010	915	865	865	.....
23	1,160	1,140	1,040	1,010	915	865	890	.....
24	1,160	1,130	1,040	990	915	865	890	.....
25	1,160	1,120	1,040	965	915	865	915	.....
26	1,160	1,120	1,040	965	915	865	940	.....
27	1,160	1,120	1,040	940	915	865	965	.....
28	1,160	1,120	1,040	915	915	865	965	.....
29	1,160	1,120	1,040	915	.....	865	965	.....
30	1,160	1,120	1,040	915	.....	865	965	.....
31	1,160	.....	1,040	915	.....	865	.....	.....

NOTE.—Stage-discharge relation affected by ice and discharge interpolated Jan. 16–22 and Feb. 1–7. No gage-height record Oct. 6–13, 15–17, 29–31; Nov. 1, 10, 11, 14–18, 22–25; Jan. 12–15, and Apr. 7–9 (discharge interpolated).

Digitized by Google

Monthly discharge of Deschutes River near Lapine, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,190	1,160	1,170	71,900
November	1,160	1,120	1,150	68,400
December	1,090	1,040	1,050	64,600
January	1,040	915	1,010	62,100
February	915	915	915	50,800
March	915	865	890	54,700
April	965	865	884	52,600
May 1-14	1,160	965	1,060	29,400
The period				454,000

DESCHUTES RIVER BELOW BEND, OREG.

LOCATION.—In SE. ¼ sec. 20, T. 17 S., R. 12 E., half a mile below North canal dam and 2 miles north of Bend, Deschutes County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 27, 1914, to September 30, 1917.

GAGE.—Stevens 8 day water-stage recorder on right bank; Gage readers, Mrs. Chas. Orewiler, Mrs. Gertrude Hogue, and John Thompson.

DISCHARGE MEASUREMENTS.—Made from cable about 50 feet upstream from gage.

CHANNEL AND CONTROL.—Rocky; shifting. Logs, drift, and aquatic plants on the wide shallow control affect stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.55 feet at 8 a. m. May 21 (discharge, 2,050 second-feet); minimum stage recorded, 1.03 feet at 1 p. m. August 16 (discharge, 420 second-feet).

1915–1917: Maximum stage recorded was that of 1917. Minimum stage recorded, 0.51 foot at 2 a. m. July 28, 1915 (discharge, 163 second-feet).

1905–1917: Maximum stage recorded, 3.45 feet at pumping plant at Bend at 7.45 a. m. November 27, 1909 (discharge, 4,820 second-feet; no diversions).

ICE.—Stage-discharge relation seldom affected by ice.

DIVERSIONS.—Station is below the intakes of the five large canals (Arnold, Central Oregon, Pilot Butte, North, and Swalley canals) which divert water from Deschutes River near Bend; only small diversions below station. Tables showing combined discharge of river and canals are published herewith.

REGULATION.—Flow regulated by hydroelectric plants at North canal dam and at Bend.

ACCURACY.—Stage-discharge relation not permanent; not affected by ice. Two fairly well-defined rating curves used, one applicable October 1 to April 25, the other June 7 to September 28. Operation of water-stage recorder unsatisfactory; many breaks in gage-height record for various periods. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting recorder graph; shifting-control method used April 26 to June 6 and September 29–30. Discharge for days of no gage-height record ascertained by interpolation based on figures obtained by first including the diversions in the five canals near Bend and then subtracting from the interpolated figures the total discharge of the canals for those days. Records fair.

Discharge measurements of Deschutes River below Bend, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 20	Batchelder and Reineking.	1.70	876	May 1	F. F. Henshaw	1.95	1,200
				29	C. L. Batchelder	2.02	1,300
Apr. 11	C. L. Batchelder	2.35	1,720	June 13	R. C. Briggs	1.94	1,300
12	do	2.18	1,450	Aug. 14	do	1.39	705

Digitized by Google

Daily discharge, in second-feet, of Deschutes River below Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	780	1,090	1,240	1,320	1,090	893	1,150	1,210	1,150	1,210	670	670
2	828	1,150	1,330	1,300	980	910	1,150	1,210	1,150	1,200	670	670
3	828	1,150	1,400	1,280	1,090	928	1,150	1,210	1,210	1,170	630	670
4	828	1,150	1,400	1,160	1,090	980	1,150	1,280	1,280	1,150	630	670
5	828	1,210	1,400	1,090	980	980	1,210	1,340	1,280	1,120	630	670
6	828	1,400	1,400	1,000	980	980	1,280	1,340	1,340	1,100	670	710
7	828	1,470	1,400	1,140	980	1,040	1,340	1,340	1,250	1,080	630	758
8	875	1,470	1,400	1,260	980	1,040	1,340	1,400	1,250	1,130	630	710
9	980	1,400	1,400	1,250	980	1,040	1,400	1,470	1,250	1,080	630	710
10	875	1,400	1,400	1,240	980	1,040	1,400	1,470	1,250	1,020	630	710
11	875	1,220	1,400	1,230	928	1,040	1,470	1,470	1,250	1,020	630	758
12	875	1,310	1,400	1,220	980	1,040	1,400	1,470	1,320	1,020	592	805
13	875	1,410	1,400	1,220	980	1,040	1,470	1,550	1,250	1,020	630	858
14	875	1,390	1,400	1,210	980	1,040	1,280	1,600	1,510	970	630	858
15	875	1,340	1,400	1,200	980	1,040	1,090	1,600	1,650	910	630	858
16	875	1,300	1,400	1,190	980	1,090	1,040	1,640	1,440	910	630	858
17	875	1,220	1,340	1,190	875	1,090	1,210	1,670	1,380	910	670	910
18	875	1,210	1,090	1,180	780	1,040	1,280	1,710	1,320	910	670	910
19	875	1,210	1,040	1,150	840	1,040	1,210	1,750	1,250	858	670	910
20	875	1,210	1,210	1,090	1,020	828	1,210	1,680	1,250	858	710	910
21	928	1,210	1,400	1,210	990	875	1,280	1,900	1,190	858	710	858
22	1,090	1,210	1,400	1,280	970	1,040	1,340	1,820	1,190	858	710	805
23	1,090	1,150	1,400	1,210	950	1,040	1,400	1,610	1,190	858	710	805
24	1,090	980	1,390	1,210	928	1,090	1,400	1,530	1,190	805	710	858
25	1,090	980	1,380	980	928	1,090	1,470	1,470	1,190	805	710	858
26	1,090	960	1,370	828	928	1,090	1,610	1,400	1,250	758	710	858
27	1,090	1,020	1,360	1,090	928	1,040	1,680	1,340	1,320	758	758	910
28	1,090	1,120	1,350	1,090	875	980	1,680	1,340	1,320	710	710	910
29	1,090	1,140	1,350	1,150	.....	1,040	1,680	1,280	1,250	710	710	910
30	1,090	1,150	1,340	1,090	.....	1,150	1,400	1,210	1,230	710	710	910
31	1,090	.....	1,330	1,150	.....	1,150	.....	1,150	.....	670	710	.....

NOTE.—No gage-height record Nov. 11-17, Nov. 26 to Dec. 2, Dec. 24 to Jan. 18, Feb. 19-23, Mar. 1-2, May 13-18, June 30 to July 6.

Daily discharge, in second-feet, of Deschutes River, including canals, near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.
1	1,450	1,400	1,370	1,330	1,100	920	1,170	1,550	1,850	2,080	1,630	1,580
2	1,500	1,470	1,390	1,320	990	930	1,170	1,560	1,850	2,070	1,630	1,570
3	1,500	1,450	1,410	1,310	1,100	950	1,170	1,560	1,850	2,050	1,590	1,580
4	1,470	1,450	1,410	1,300	1,100	1,000	1,180	1,620	1,930	2,030	1,590	1,590
5	1,500	1,510	1,410	1,300	990	1,000	1,240	1,620	1,950	2,020	1,580	1,580
6	1,490	1,510	1,410	1,290	990	1,020	1,310	1,710	1,970	2,000	1,630	1,580
7	1,480	1,580	1,410	1,280	990	1,180	1,370	1,720	2,000	1,980	1,590	1,620
8	1,450	1,580	1,410	1,270	990	1,060	1,360	1,780	2,010	1,980	1,590	1,570
9	1,500	1,510	1,410	1,260	990	1,060	1,420	1,850	2,030	1,990	1,570	1,570
10	1,480	1,560	1,410	1,250	990	1,060	1,420	1,900	2,030	1,950	1,590	1,560
11	1,450	1,520	1,410	1,240	1,000	1,050	1,530	1,930	2,040	1,930	1,590	1,570
12	1,450	1,470	1,410	1,230	1,000	1,050	1,466	1,930	2,120	1,930	1,550	1,590
13	1,450	1,430	1,410	1,230	1,000	1,050	1,530	1,970	2,060	1,940	1,590	1,640
14	1,440	1,390	1,410	1,220	1,000	1,050	1,500	2,010	2,130	1,880	1,590	1,640
15	1,430	1,340	1,410	1,210	1,000	1,050	1,410	2,040	2,170	1,830	1,590	1,600
16	1,430	1,300	1,410	1,200	1,000	1,100	1,360	2,080	2,200	1,830	1,590	1,590
17	1,430	1,250	1,400	1,200	1,000	1,100	1,300	2,110	2,200	1,830	1,610	1,630
18	1,440	1,210	1,350	1,190	1,080	1,050	1,300	2,150	2,090	1,850	1,540	1,610
19	1,450	1,250	1,350	1,180	1,060	1,080	1,230	2,190	2,110	1,780	1,530	1,600
20	1,450	1,240	1,440	1,120	1,040	1,070	1,230	2,120	2,110	1,790	1,550	1,620
21	1,440	1,240	1,410	1,220	1,010	1,060	1,300	2,100	2,060	1,790	1,550	1,550
22	1,430	1,250	1,410	1,290	990	1,050	1,360	2,140	2,070	1,790	1,540	1,550
23	1,430	1,190	1,410	1,220	970	1,050	1,440	2,030	2,060	1,790	1,550	1,550
24	1,420	1,190	1,400	1,320	950	1,100	1,440	1,960	2,060	1,720	1,560	1,600
25	1,420	1,260	1,390	1,190	950	1,110	1,500	1,910	2,080	1,720	1,570	1,570
26	1,400	1,280	1,380	1,040	950	1,110	1,640	1,900	2,130	1,680	1,570	1,540
27	1,400	1,300	1,370	1,170	950	1,160	1,710	1,840	2,170	1,680	1,620	1,600
28	1,420	1,320	1,360	1,100	900	1,160	1,710	1,880	2,180	1,670	1,580	1,590
29	1,420	1,340	1,360	1,160	.....	1,140	1,730	1,840	2,100	1,660	1,590	1,560
30	1,420	1,350	1,350	1,100	.....	1,170	1,610	1,810	2,100	1,660	1,610	1,550
31	1,420	.....	1,340	1,160	.....	1,170	.....	1,830	.....	1,720	1,620	.....

NOTE.—Discharge in this table interpolated for periods indicated in footnote to preceding table.

Digitized by Google

Monthly discharge of Deschutes River below Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,090	780	937	57,600
November	1,470	960	1,220	72,600
December	1,400	1,040	1,350	83,000
January	1,320	828	1,170	71,900
February	1,090	780	963	53,500
March	1,150	828	1,020	62,700
April	1,680	1,040	1,340	79,700
May	1,900	1,150	1,470	90,400
June	1,650	1,150	1,280	76,200
July	1,210	670	940	57,800
August	758	592	669	41,100
September	910	670	809	48,100
The year	1,900	592	1,100	795,000

Monthly discharge of Deschutes River, including canals, near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,500	1,400	1,450	89,200
November	1,580	1,190	1,370	81,500
December	1,440	1,340	1,390	85,500
January	1,330	1,040	1,220	75,000
February	1,100	900	1,000	55,500
March	1,180	920	1,070	65,800
April	1,730	1,170	1,400	33,300
May	2,190	1,550	1,890	116,000
June	2,200	1,850	2,060	123,000
July	2,080	1,660	1,860	114,000
August	1,630	1,530	1,580	97,200
September	1,640	1,540	1,580	94,000
The year	2,200	900	1,490	1,080,000

DESCHUTES RIVER AT MECCA, OREG.

LOCATION.—In SW. ¼ sec. 20, T. 9 S., R. 13 E., at bridge at Mecca station on Oregon Trunk Railway, Jefferson County, 1½ miles below mouth of Shitike Creek and 12 miles above mouth of Warm Springs River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 7, 1911, to September 30, 1917.

GAGE.—Vertical staff fastened to tree on right bank 75 feet above bridge. Gage reader, William H. See.

DISCHARGE MEASUREMENTS.—Made from highway bridge.

CHANNEL AND CONTROL.—Rock and gravel; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.7 feet April 27 (discharge, 11,600 second-feet); minimum discharge, 4,070 second-feet for several days in October, January, February, and March.

1911–1917: Maximum stage recorded, 5.75 feet March 21, 1916 (discharge, 11,700 second-feet); minimum stage recorded 1.95 feet in August and September, 1915 (discharge, 3,410 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Flow affected by same diversions from upper Deschutes River at Bend, Laidlaw, and Cline Falls stations. Summer flow of Crooked River above head of Lower canyon near Terrebonne practically all diverted.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during high water April 27. Rating curves well defined between 4,000 and 6,500 second-feet. Gage read to half-tenths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records excellent.

Digitized by Google

Discharge measurements of Deschutes River at Mecca, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 13	C. L. Batchelder	4.52	8,570	Aug. 9	R. C. Briggs	2.50	4,390
May 27	do	3.70	6,600	Sept. 16	F. F. Henshaw	2.54	4,290
Aug. 8	R. C. Briggs	2.50	4,400				

Daily discharge, in second-feet, of Deschutes River at Mecca, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4,250	4,450	4,900	4,900	4,070	4,450	5,370	7,800	6,840	5,300	4,400	4,100
2	4,070	4,450	4,900	4,900	4,450	4,450	5,370	7,320	6,360	5,500	4,400	4,100
3	4,070	4,450	4,900	4,900	4,670	4,450	4,900	7,080	6,360	5,500	4,400	4,100
4	4,250	4,670	4,900	4,900	4,450	4,450	4,900	7,320	6,140	5,500	4,400	4,100
5	4,450	4,450	4,900	4,450	4,670	4,670	5,130	7,320	6,140	5,500	4,400	4,100
6	4,450	4,670	4,900	4,450	4,450	4,450	5,370	7,560	5,920	5,500	4,400	4,250
7	4,450	4,900	4,900	4,450	4,450	4,450	6,850	7,800	5,920	5,500	4,400	4,250
8	4,450	4,900	4,900	4,450	4,450	4,450	7,850	8,780	6,140	5,300	4,400	4,100
9	4,450	4,900	4,900	4,670	4,450	4,670	8,100	9,040	6,360	5,300	4,250	4,100
10	4,450	4,900	4,900	4,670	4,450	4,670	8,350	9,040	6,140	5,100	4,100	4,100
11	4,450	4,900	4,900	4,450	4,450	4,450	7,850	9,040	5,700	5,100	4,100	4,250
12	4,450	4,450	4,900	4,450	4,450	4,450	8,600	9,300	5,500	5,100	4,100	4,250
13	4,450	4,450	4,900	4,450	4,450	4,450	8,850	9,560	5,500	5,100	4,100	4,250
14	4,450	4,450	4,900	4,450	4,450	4,450	7,850	9,300	5,500	5,100	4,100	4,400
15	4,450	4,450	4,900	4,450	4,450	4,450	7,350	9,040	5,920	5,100	4,250	4,400
16	4,250	4,670	4,900	4,250	4,450	4,450	6,850	8,780	6,360	5,300	4,250	4,400
17	4,250	4,670	4,900	4,070	4,670	4,450	6,600	8,280	6,140	5,500	4,250	4,400
18	4,250	4,900	4,670	4,250	4,450	4,450	6,350	7,800	5,920	5,300	4,250	4,400
19	4,250	4,900	4,450	4,450	4,250	4,450	6,100	7,320	5,920	5,300	4,250	4,400
20	4,250	4,900	4,450	4,450	4,450	4,250	5,850	7,320	5,920	5,100	4,400	4,400
21	4,250	4,900	4,450	4,450	4,450	4,070	6,350	7,320	5,920	5,100	4,400	4,400
22	4,450	4,900	4,900	4,900	4,450	4,450	7,600	7,320	5,700	5,100	4,400	4,400
23	4,450	4,900	4,900	4,900	4,450	4,450	7,850	6,840	5,500	4,920	4,400	4,400
24	4,450	4,900	4,670	4,670	4,900	4,670	9,100	6,600	5,300	4,740	4,250	4,400
25	4,450	4,670	4,670	4,450	4,450	4,670	10,800	6,360	5,100	4,560	4,250	4,400
26	4,450	4,900	4,670	4,450	4,450	4,900	10,800	6,360	5,500	4,740	4,100	4,400
27	4,450	4,900	4,450	4,450	4,450	5,130	11,600	6,600	5,500	4,740	4,100	4,400
28	4,450	4,900	4,450	4,450	4,450	5,130	10,600	6,600	5,500	4,740	4,100	4,400
29	4,450	4,900	4,450	4,670	.....	6,600	9,560	6,840	5,500	4,740	4,100	4,400
30	4,450	4,900	4,450	4,670	.....	7,100	8,780	6,840	5,300	4,560	4,100	4,400
31	4,450	.....	4,450	4,450	.....	5,850	.....	6,840	.....	4,400	4,100	.....

Monthly discharge of Deschutes River at Mecca, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	4,450	4,070	4,370	269,000
November	4,900	4,450	4,740	282,000
December	4,900	4,450	4,750	292,000
January	4,900	4,070	4,550	280,000
February	4,900	4,070	4,470	248,000
March	7,100	4,070	4,730	291,000
April	11,600	4,900	7,580	451,000
May	9,560	6,360	7,720	475,000
June	6,840	5,100	5,850	348,000
July	5,500	4,400	5,110	314,000
August	4,400	4,100	4,250	261,000
September	4,400	4,100	4,300	256,000
The year	11,600	4,070	5,200	3,770,000

Digitized by Google

DESCHUTES RIVER AT MOODY, NEAR BIGGS, OREG.

LOCATION.—In SE. ¼ sec. 26, T. 2 N., R. 15 E., opposite Moody railroad station, 1¼ miles above bridge of Oregon-Washington Railroad & Navigation Co., 1½ miles above mouth of river, and about 5 miles southwest of Biggs, Sherman County.

DRAINAGE AREA.—About 9,180 square miles.

RECORDS AVAILABLE.—July 7, 1906, to September 30, 1917; October 19, 1897, to December 31, 1899, for a station near Moro, 10 miles above mouth of river in the NE. ¼ sec. 5, T. 1 S., R. 16 E. Records for 1908 and 1910 somewhat fragmentary.

GAGE.—Staff in two sections, the lowest inclined, the upper vertical. Gage reader, W. Ryan. At the Moro station gage was an inclined staff.

DISCHARGE MEASUREMENTS.—Made from cable about 450 feet above gage. At Moro station made from the "free bridge" 3 miles below gage.

CHANNEL AND CONTROL.—Rock and gravel; shifting only in floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.8 feet April 30 (discharge, 14,500 second-feet); minimum stage recorded, 2.25 feet September 2 to 4 (discharge, 4,350 second-feet).

1906–1917: Maximum stage recorded, 7.50 feet February 6, 1907 (discharge, 30,600 second-feet); minimum stage recorded, 1.9 feet August 18 to September 16, 1915 (discharge, 3,600 second-feet).

ICE.—Stage-discharge relation never affected by ice.

DIVERSIONS.—Summer discharge at this station has been progressively reduced since about 1904 or 1905 by diversions from the upper river. Some of this water returns but the net reduction during midsummer is now probably 15 to 20 per cent.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during flood at end of April. Rating curve used October 1 to April 29 well defined between 3,600 and 15,000 second-feet; curve used April 30 to September 30 well defined between 4,200 and 12,000 second-feet. Gage read to half-tenths once daily. Daily discharge ascertained by applying daily gage height to rating tables. Records excellent.

Discharge measurements of Deschutes River at Moody, near Biggs, Oreg., during the year ending Sept. 30, 1917.

[Made by C. L. Batchelder.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
May 23	3.60	8,740
Aug. 23	2.30	4,590

Digitized by Google

Daily discharge, in second-feet, of Deschutes River at Moody, near Biggs, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	5,000	5,600	5,600	5,600	5,300	5,300	8,200	13,500	9,250	6,600	4,600	4,600
2	5,000	5,600	5,600	5,600	5,600	5,300	7,500	12,500	9,250	6,600	4,600	4,350
3	5,000	5,600	5,600	5,600	5,600	5,300	6,800	10,600	8,800	6,600	4,600	4,350
4	5,000	5,600	5,600	5,300	5,600	5,300	6,500	10,200	8,800	6,600	4,600	4,350
5	5,000	5,600	5,600	5,300	5,900	5,300	6,800	9,700	8,400	6,600	4,600	4,600
6	5,000	5,600	5,600	5,300	5,600	5,600	7,500	9,250	8,400	6,600	4,600	4,600
7	5,000	5,600	5,600	5,300	5,600	5,600	6,800	9,700	8,000	6,600	4,600	4,600
8	5,000	5,600	5,600	5,300	5,600	5,900	8,200	10,200	8,000	6,300	4,600	4,600
9	5,000	5,600	5,600	5,300	5,300	5,300	9,300	10,600	8,400	6,300	4,600	4,600
10	5,000	5,600	5,600	5,300	5,300	5,300	10,100	11,500	8,400	6,300	4,600	4,600
11	5,000	5,600	5,600	5,300	5,300	5,300	10,100	12,500	8,400	6,300	4,350	4,600
12	5,000	5,600	5,600	5,300	5,300	5,300	10,500	12,000	8,400	6,300	4,350	4,600
13	5,000	5,300	5,600	5,300	5,300	5,300	10,100	12,500	8,000	6,010	4,350	4,600
14	5,000	5,300	5,600	5,300	5,300	5,300	9,700	13,000	8,000	6,010	4,350	4,600
15	5,000	5,300	5,600	5,300	5,300	5,300	8,900	12,500	8,000	6,010	4,350	4,870
16	5,000	5,300	5,600	5,300	5,300	5,300	8,200	12,000	7,600	6,010	4,600	4,870
17	5,000	5,300	5,600	5,300	5,300	5,300	7,850	12,000	7,600	5,720	4,600	4,870
18	5,000	5,300	5,600	5,300	5,300	5,300	7,850	11,500	7,600	5,720	4,600	4,870
19	5,000	5,300	5,300	5,300	5,300	5,300	7,500	10,600	7,600	5,720	4,600	4,870
20	5,000	5,300	5,300	5,300	5,300	5,300	7,500	10,200	7,600	5,720	4,600	4,870
21	5,000	5,300	5,300	5,300	5,300	5,300	7,500	9,700	7,600	5,720	4,600	4,600
22	5,000	5,300	5,300	5,300	5,300	5,600	7,850	9,250	7,600	5,430	4,350	4,600
23	5,000	5,300	5,300	5,300	5,300	5,900	8,200	8,800	7,600	5,430	4,600	4,600
24	5,000	5,300	5,300	5,300	5,300	6,200	8,550	8,800	7,250	5,430	4,600	4,600
25	5,000	5,300	5,300	5,300	5,300	6,200	8,900	8,800	7,250	5,150	4,600	4,600
26	5,000	5,300	5,300	5,300	5,300	6,200	9,300	8,400	6,900	5,150	4,600	4,600
27	5,300	5,600	5,300	5,300	5,300	6,500	10,500	8,400	6,900	4,870	4,600	4,600
28	5,300	5,600	5,300	5,300	5,300	6,800	11,400	8,800	6,600	4,870	4,600	4,600
29	5,300	5,300	5,300	5,300	.....	7,500	13,200	8,800	6,600	4,870	4,600	4,600
30	5,600	5,600	5,600	5,300	.....	8,200	14,500	9,250	6,600	4,600	4,600	4,600
31	5,600	.....	5,300	5,300	.....	8,550	.....	9,250	.....	4,600	4,600	.....

Monthly discharge of Deschutes River at Moody, near Biggs, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	5,600	5,000	5,070	312,000
November	5,600	5,300	5,450	324,000
December	5,600	5,300	5,480	337,000
January	5,600	5,300	5,330	328,000
February	5,900	5,300	5,390	299,000
March	8,550	5,300	5,810	357,000
April	14,500	6,500	8,860	527,000
May	13,500	8,400	10,500	646,000
June	9,250	6,600	7,850	467,000
July	6,600	4,600	5,830	358,000
August	4,600	4,350	4,550	280,000
September	4,870	4,350	4,630	276,000
The year	14,500	4,350	6,230	4,510,000

Digitized by Google

EAST FORK AT MORSON INTAKE, NEAR LAPINE, OREG.

LOCATION.—In NE. ¼ sec. 34, T. 23 S., R. 9 E., at private road bridge about half a mile from river road to Crescent, and 12 miles southwest of Lapine, Deschutes County. Up to July 27, 1915, and since May 19, 1917, in SE. ¼ sec. 33, T. 23 S., R. 9 E., about 500 feet below mouth of Crescent Creek, just above proposed intake for Deschutes Land Co., Carey Act segregation.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 26, 1914, to September 14, 1917, except winter periods. Station discontinued.

GAGE.—Vertical staff nailed to bent of bridge; vertical staff nailed to a tree root at upstream site. Friez water-stage recorder used August 12 to November 21, 1914. Gage reader, George M. Mayfield.

DISCHARGE MEASUREMENTS.—Made by wading or from road bridge.

CHANNEL AND CONTROL.—Bed composed of gravel and sand, with steep banks of silt, overgrown with brush; may shift. in floods. Channel divided by an island just below bridge.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.73 feet at upper gage, June 12 (discharge, 835 second-feet), minimum stage recorded, 1.12 feet at lower (bridge) gage, October 25 and 28 (discharge, 100 second-feet).

1914-1917: Maximum stage is that of 1917; flood of November 25, 1909, may have reached 1,800 second-feet (estimated from records at Allen's ranch). Minimum stage recorded, 0.40 foot September 3 to 11, 1915 (discharge, 40 second-feet).

ICE.—Stream is frozen two or three months; no winter records have been obtained.

DIVERSIONS.—A few small ditches divert water above the station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent at bridge gage while record was obtained there. At gage above Morson intake stage-discharge relation changed during spring high water. Rating curve for bridge gage fairly well defined between 100 and 500 second-feet. For gage above Morson intake curve fairly well defined throughout. Gage read once on days for which discharge record is given. Daily discharge ascertained by applying daily gage height to rating table. Records fair.

Discharge measurements of East Fork at Morson intake, near Lapine, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.		Discharge.		
		Upper gage.	Bridge gage.	River at bridge gage.	Morson canal.	Total river above Morson canal.
		Feet.	*Feet.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
Oct. 13	C. L. Batchelder	.....	1.15	104	0	104
May 13	F. F. Henshaw	.....	4.45	722	0	722
June 2	Briggs and Batchelder	.....	2.75	350	230	580
14	R. C. Briggs	6.45	2.90	391	326	717
Aug. 19	.....do	4.42	0.51	41	116	157

Digitized by Google

Daily discharge, in second-feet, of East Fork at Morson intake, near Lapine, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	May.	June.	July.	Aug.	Sept.
1	110	108	161					
2					580	480		
3	110	112	161				238	152
4								
5	110	135	156			480	192	
6								
7	108	132	156					
8								143
9	108	135	152			450		
10							172	134
11	104	132				435		
12					835		168	
13	104	128		722				
14					732	420		125
15	104	135						
16						420		
17	104	135					162	
18						405		
19	104	135		698	766		156	
20								
21	104	132				390		
22					732			
23	104	135				390		
24							156	
25	100	135			616			
26								
27		156						
28	100				540	349		
29		164						
30	104					286		
31								

Monthly discharge of East Fork River at Morson intake, near Lapine, Oreg., for the year ending Sept. 30, 1917.

Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).	Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).
October	105	6,460	July	410	25,200
November	134	7,970	August	178	10,900
December 1–9	157	2,800	September 1–14	138	3,830
June	686	40,800			

NOTE.—Monthly mean discharge is average of discharge determined for days when gage was read.

ARNOLD CANAL NEAR BEND, OREG.

LOCATION.—In SW. ¼ sec. 23, T. 18 S., R. 11 E., about a mile below intake of canal and 9 miles south of Bend, Deschutes County.

RECORDS AVAILABLE.—April 10, 1914, to September 30, 1917; information sufficient for a rough estimate October, 1912, to March, 1914.

GAGE.—Vertical staff on right side of flume 400 feet below a spillway, installed May 12, 1917; staff on left side just below spillway used May 1, 1915, to December 2, 1916. A gage one-half mile above, in the NE. ¼ sec. 27, was used up to April 30, 1915. Gage readers, Joe Stenkamp and B. Tekampe.

DISCHARGE MEASUREMENTS.—Made from collar of flume near gage.

CHANNEL AND CONTROL.—Flume 12 to 14 feet wide; fairly steep gradient.

EXTREMES OF DISCHARGE.—1914–1917: Maximum stage recorded, 2.18 feet June 23 and 27, 1917 (discharge, 114 second-feet); canal dry at various times during year.

Digitized by Google

ACCURACY.—Stage-discharge relation not permanent. Rating curves applicable as follows: Curve well defined below 100 second-feet, October 1 to December 2; fairly well defined curve applicable directly, May 2 to June 2, and by shifting-control method, June 4 to 19; curve well defined between 30 and 110 second-feet, June 21 to September 30. Gage read to hundredths once each day when water was flowing, October to December; and on alternate days, May to September. Daily discharge ascertained by applying daily gage height to rating table, interpolating for days when gage was not read. Records good except for May and June, for which they are fair.

Arnold canal diverts water from the right bank of Deschutes River at the head of Lava Island, in the SW. ¼ sec. 27, T. 18 S., R. 11 E., and irrigates land south and east of Bend lying above the Central Oregon Irrigation Co.'s Carey Act segregation.

Discharge measurements of Arnold canal near Bend, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.		Discharge.
		Old gage.	New Gage.[a]	
		Feet.	*Feet.*	*Sec.-ft.*
Oct. 20	Batchelder and Reineking	1.55	.....	67
May 12	F. F. Henshaw	.80	1.06	27.1
29	C. L. Batchelder	.95	1.22	33.4
June 4	Briggs and Batchelder	1.20	1.45	50
Aug. 15	R. C. Briggs	1.71	2.10	106
22	.....do	1.28	1.63	70

[a] Installed May 12, 1917.

Daily discharge, in second-feet of Arnold canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	May.	June.	July.	Aug.	Sept.
1	72	49	41	.....	34	108	101	106
2	72	52	41	4	45	106	106	106
3	72	52	.....	8	48	106	110	106
4	72	52	.....	8	50	104	110	104
5	72	52	.....	8	53	102	108	102
6	68	46	.....	8	56	104	106	102
7	68	46	.....	.....	62	106	106	104
8	72	46	.....	.....	67	106	106	106
9	72	46	.....	.....	78	106	106	106
10	72	46	.....	26	78	106	106	106
11	72	46	.....	26	78	106	110	106
12	72	23	.....	26	77	106	108	106
13	72	.....	.....	27	86	106	106	102
14	68	.....	.....	28	89	106	106	98
15	68	.....	.....	28	92	106	106	74
16	68	.....	.....	28	95	106	106	74
17	68	.....	.....	28	98	106	106	74
18	68	.....	.....	29	107	106	106	74
19	68	31	.....	24	110	106	88	74
20	68	19	.....	19	110	106	70	76
21	68	19	.....	14	110	98	70	78
22	65	27	.....	.....	112	98	70	78
23	65	36	.....	.....	114	98	80	76
24	62	36	.....	17	112	96	90	74
25	62	36	.....	24	110	94	106	76
26	62	36	.....	34	112	96	106	78
27	62	41	.....	34	114	99	106	78
28	62	41	.....	34	112	102	106	78
29	62	41	.....	34	110	100	106	78
30	62	41	.....	34	110	98	106	78
31	62	.....	.....	34	.....	100	106	.....

NOTE.—Canal dry Nov. 13–18, Dec. 3 to May 1, May 7–9, and May 22–23. Gage heights May 2–6 and 10–11 estimated by observer on May 12.

Digitized by Google

Monthly discharge of Arnold canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	72	62	67.7	4,160
November (24 days)	52	19	40.0	1,900
December (2 days)	41	41	41.0	163
May (25 days)	34	4	23.4	1,160
June	114	34	87.6	5,210
July	108	94	103	6,330
August	110	70	101	6,210
September	106	74	89.3	5,310
The year				30,400

CENTRAL OREGON CANAL NEAR BEND, OREG.

LOCATION.—In NE. ¼ sec. 7, T. 18 S., R. 12 E., at a flume section about half a mile below point where waters in main diversion canal are divided between this canal and Pilot Butte canal, about 2 miles south of Bend, Deschutes County.

RECORDS AVAILABLE.—May 11, 1905, to September 30, 1917.

GAGE.—Vertical enameled staff nailed to inside of flume on right side. Gage reader, J. A. Watson.

DISCHARGE MEASUREMENTS.—Made from yoke of flume at gage section.

CHANNEL AND CONTROL.—A plank flume of rectangular cross section with battened seams. Flume rather unstable but the rating appears not to change.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and during period 1905–1917, 3.78 feet at 5 p. m. August 14 (discharge 385 second-feet). Canal dry at various times during year.

ICE.—Canal operated in winter but only during periods of moderately cold weather, for furnishing water for domestic use. The velocity of the water passing the gage is sufficient to maintain open channel at all times.

Central Oregon canal diverts water from the right bank of Deschutes River in the NE. ¼ sec. 13, T. 18 S., R. 12 E., and irrigates land lying to the east of Bend and in the vicinity of Powell Buttes.

ACCURACY.—Stage-discharge ralation practically permanent. Rating curve well defined. Gage read to half-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good for irrigating season; fair for period November to March.

COOPERATION.—Gage record height furnished by Central Oregon Irrigation Co.

Discharge measurements of Central Oregon canal near Bend, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
May 31	Briggs and Batchelder	3.20	317
Aug. 14	R. C. Briggs	3.78	391

Digitized by Google

Daily discharge, in second-feet, of Central Oregon canal near Bend, Oreg., for the year ending Sept. 30 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	272	.....	74	.....	.....	.....	.....	170	299	355	385	355
2	272	.....	13	.....	.....	.....	.....	182	299	355	385	355
3	272	.....	.....	.....	.....	.....	.....	182	299	355	385	355
4	246	.....	.....	47	.....	.....	.....	170	299	355	385	370
5	272	.....	.....	134	.....	.....	.....	170	299	370	385	370
6	272	.....	.....	127	.....	.....	.....	182	261	370	385	370
7	259	.....	.....	.....	.....	.....	.....	182	327	370	385	270
8	207	.....	.....	.....	.....	.....	.....	182	327	299	385	370
9	170	.....	.....	.....	.....	.....	.....	182	327	370	370	370
10	246	57	.....	.....	.....	.....	.....	194	313	370	385	370
11	220	182	.....	.....	.....	.....	.....	220	327	370	385	355
12	220	106	.....	.....	.....	.....	.....	220	327	370	385	341
13	220	.....	.....	.....	.....	.....	.....	194	327	370	385	341
14	220	.....	.....	.....	.....	.....	120	182	327	370	385	341
15	220	.....	.....	.....	.....	.....	170	220	341	370	385	341
16	220	.....	.....	.....	.....	.....	170	220	341	370	385	341
17	220	.....	54	.....	97	.....	57	220	341	370	385	341
18	220	.....	140	.....	152	.....	.....	220	341	385	355	341
19	207	.....	170	.....	82	24	.....	220	355	370	355	327
20	207	.....	64	.....	.....	112	.....	220	355	370	355	327
21	155	.....	.....	.....	.....	50	.....	9	355	385	355	327
22	.....	.....	.....	.....	.....	.....	.....	128	355	385	355	327
23	.....	.....	.....	.....	.....	.....	.....	220	355	385	355	327
24	.....	20	.....	.....	.....	.....	.....	220	355	370	355	327
25	.....	57	.....	84	.....	.....	.....	220	370	370	355	299
26	.....	92	.....	92	.....	.....	.....	246	355	370	355	272
27	.....	123	.....	24	.....	97	.....	246	355	370	355	272
28	.....	123	.....	.....	.....	158	.....	259	355	385	355	272
29	.....	123	.....	.....	.....	86	18	272	355	385	355	246
30	.....	123	.....	.....	.....	.....	97	285	355	385	355	246
31	.....	.....	.....	.....	.....	.....	.....	299	.....	385	355	.....

NOTE.—Canal dry during periods for which no discharge is given.

Monthly discharge of Central Oregon canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October (21 days)	272	155	229	9,540
November (10 days)	182	20	101	2,000
December (6 days)	170	13	85.8	1,020
January (6 days)	134	24	84.7	1,010
February (3 days)	152	82	110	655
March (6 days)	158	24	87.8	1,040
April (6 days)	170	18	105	1,250
May	299	9	204	12,500
June	370	261	333	19,800
July	385	299	370	22,800
August	385	355	371	22,800
September	370	246	332	19,800
The year	.....	.....	.....	114,000

PILOT BUTTE CANAL NEAR BEND, OREG.

LOCATION.—In NE. ¼ sec. 7, T. 18 S., R. 12 E., at a point in canal directly opposite gaging station on Central Oregon canal half a mile below point where waters are divided between this canal and Central Oregon canal and about 2 miles south of Bend, Deschutes County.

RECORDS AVAILABLE.—March 6, 1905, to September 30, 1917.

GAGE.—Vertical staff on right bank. Gage reader, J. A. Watson.

DISCHARGE MEASUREMENTS.—Made by wading at the gage.

Digitized by Google

CHANNEL AND CONTROL.—Bed composed of gravel and sand. Control partly solid rock; somewhat shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 1.80 feet, October 1 to 8 (discharge 42 second-feet). Canal dry at various times.

1905–1917: Maximum stage recorded 3.10 feet, June 8, 11 to 16, July 19 to 21, 1913 (discharge 244 second-feet). Canal dry at various times.

ICE.—Canal operated intermittently during winter to provide water for stock and domestic use. Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation changed during year. Rating curve used October 1 to 8 well defined between 15 and 60 second-feet. Curve used from October 16 to September 30 fairly well defined between 15 and 44 second-feet. Gage read to half-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Pilot Butte canal diverts water from the right bank of Deschutes River in the NE. ¼ sec. 13, T. 18 S., R. 12 E., in a flume common to it and the Central Oregon canal for irrigating lands lying mostly north of Bend and extending nearly to Crooked River. North canal also diverts water into the Pilot Butte.

Discharge measurements of Pilot Butte canal near Bend, Oreg., during the year ending Sept. 30 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 20	Batchelder and Reineking	1.45	17.7	Aug. 15	R. C. Briggs	1.71	39.4
May 31	Batchelder and Briggs	1.46	17.1	21	do	1.72	36.8

Daily discharge, in second-feet, of Pilot Butte canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	42		10					20	18	24	35	35
2	42							20	18	29	35	35
3	42							20	18	35	35	35
4	42			15				20	18	35	35	35
5	42			35				20	18	35	35	35
6	42			26				20	19	35	35	35
7	42							20	20	26	35	35
8	17							20	24	35	35	35
9								20	20	35	35	35
10								20	20	35	35	35
11		12						20	19	18	35	35
12		31						20	24	35	35	35
13		20						24	24	35	35	35
14							11	20	24	35	35	35
15							20	20	24	35	35	35
16							20	20	24	35	35	35
17					12		7	20	24	35	35	35
18	4				15			20	24	35	35	35
19	15				8	4		20	24	35	35	35
20	15					15		20	24	35	35	35
21	11					6		1	24	35	35	35
22								11	27	35	35	35
23								20	20	35	35	35
24		6						20	24	35	35	35
25		20		12				20	24	35	35	27
26		27		8				20	24	35	35	24
27		27						20	24	35	35	27
28		27						20	24	35	35	27
29		27					3	20	24	35	35	29
30		27					15	20	24	35	35	24
31								19		35	35	

NOTE.—Canal dry during periods for which no discharge is given.

Digitized by Google

Monthly discharge of Pilot Butte canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October (12 days)	42	4	29.7	707
November (10 days)	31	6	22.4	444
December (1 day)	10	10	10.0	20
January (5 days)	35	8	19.2	190
February (3 days)	15	8	11.7	70
March (3 days)	15	4	8.3	49
April (6 days)	20	3	12.7	151
May	24	1	19.2	1,180
June	27	18	22.2	1,320
July	35	18	33.6	2,070
August	35	35	35.0	2,150
September	35	24	33.3	1,980
The year				10,300

NORTH CANAL NEAR BEND, OREG.

LOCATION.—In NE. ¼ sec. 29, T. 17 S., R. 13 E., about 500 feet below bridge on road to Tumalo, a quarter of a mile below intake, and about a mile north of Bend, Deschutes County.

RECORDS AVAILABLE.—June 14, 1913, to September 30, 1917.

GAGE.—Painted on left side of concrete lining of flume. Gage reader, C. Orewiler.

DISCHARGE MEASUREMENTS.—Made from plank across canal.

CHANNEL AND CONTROL.—Concrete-lined section extends about 1,000 feet below gage; below this point the canal is unlined and sides and bottom are very rough. Changes in unlined section affect stage-discharge relation.

EXTREMES OF DISCHARGE.—1913–1917: Maximum stage recorded 5.57 feet during parts of July, August, and September, 1917 (discharge, 340 second-feet). Canal dry at various times.

ICE.—Only a small quantity of water diverted in winter for stock; stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation changed by repairs to canal while water was out during latter part of March. Two well-defined rating curves used, one applicable before, the other after April 1. Gage read to half-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Record excellent except for November and April; only fair for these months because of uncertainty as to length of time water was running during days when it was turned in or out.

North canal diverts water from the right bank of Deschutes River at a concrete dam about 60 feet high, in the NE. ¼ sec. 29, T. 17 S., R. 13 E., and extends eastward for about a mile, where it discharges the water into Pilot Butte canal.

Digitized by Google

Discharge measurements of North canal near Bend, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Apr. 12..	C. L. Batchelder.....	1.20	32.9	June 13..	R. C. Briggs.....	5.19	301
May 29..	.....do.....	3.85	195	Aug. 14 .	.....do.....	5.54	339
May 31..	Briggs and Batchelder .	4.55	245				

Daily discharge, in second-feet, of North canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.
1.....	217	203	.....	.....	.....	.....	.....	106	277	312	340	340
2.....	217	203	.....	9	.....	.....	.....	100	277	312	340	340
3.....	217	182	.....	26	.....	.....	.....	100	277	312	340	340
4.....	217	182	.....	65	.....	.....	.....	100	281	312	340	340
5.....	217	182	.....	130	.....	.....	.....	100	294	321	340	330
6.....	217	.....	.....	130	.....	27	.....	119	294	321	340	294
7.....	217	.....	.....	130	.....	118	.....	133	294	321	340	285
8.....	217	.....	.....	.....	.....	.....	.....	133	303	321	340	285
9.....	217	.....	.....	.....	.....	.....	.....	133	303	321	340	285
10.....	217	.....	.....	.....	.....	.....	.....	147	303	321	340	269
11.....	217	.....	.....	.....	51	.....	33	154	303	330	340	245
12.....	217	.....	.....	.....	.....	.....	33	147	303	321	340	237
13.....	217	.....	.....	.....	.....	.....	33	133	306	321	340	237
14.....	217	.....	.....	.....	.....	.....	64	133	117	321	340	237
15.....	203	.....	.....	.....	.....	.....	106	133	.....	321	340	221
16.....	203	.....	.....	.....	.....	.....	106	133	238	321	340	213
17.....	203	32	.....	.....	.....	.....	.....	133	303	321	340	197
18.....	203	.....	107	.....	107	.....	.....	133	232	330	303	182
19.....	217	.....	136	20	130	.....	.....	133	303	330	303	189
20.....	217	.....	161	20	.....	97	.....	133	303	330	303	205
21.....	217	.....	.....	.....	.....	112	.....	133	312	330	303	221
22.....	217	.....	.....	.....	.....	.....	.....	133	312	330	303	237
23.....	217	.....	.....	.....	.....	.....	17	133	312	330	303	245
24.....	203	136	.....	102	.....	.....	17	133	312	330	303	245
25.....	203	161	.....	102	.....	.....	8	133	312	330	303	245
26.....	189	161	.....	102	.....	.....	.....	161	312	330	303	245
27.....	189	80	.....	51	.....	.....	.....	161	285	340	303	245
28.....	203	.....	.....	.....	.....	.....	.....	182	294	340	312	237
29.....	203	.....	.....	.....	.....	.....	.....	196	294	340	321	229
30.....	203	.....	.....	.....	.....	.....	60	228	312	340	330	229
31.....	203	.....	.....	.....	.....	.....	.....	258	.....	340	340	.....

NOTE.—No flow during periods for which discharge is not given.

Monthly discharge of North canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October.....	217	189	211	13,000
November (10 days).....	203	32	152	3,020
December (3 days).....	161	107	135	803
January (12 days).....	130	9	73.9	1,760
February (3 days).....	130	51	96.0	571
March (4 days).....	118	27	88.5	702
April (10 days).....	106	8	47.7	946
May.....	258	160	141	8,670
June (29 days).....	312	117	289	16,600
July.....	340	312	326	20,000
August.....	340	303	326	20,000
September.....	340	182	255	15,200
The year.....	.....	.....	.....	101,000

Digitized by Google

SWALLEY CANAL NEAR BEND, OREG.

LOCATION.—In NE. ¼ sec. 29, T. 17 S., R. 12 E., about 100 yards above road crossing, a quarter of a mile below intake of canal at North canal dam and about 1½ miles north of Bend, Deschutes County.

RECORDS AVAILABLE.—June 1, 1913, to September 30, 1917.

GAGE.—Vertical staff on right bank at lower end of intake flume. Gage readers, Charles Orewiler and Arch Hogue.

DISCHARGE MEASUREMENTS.—Made from plank laid across flume.

CHANNEL AND CONTROL.—Earth canal of regular cross section and practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 2.30 feet at 5 p. m. July 10 (discharge, 102 second-feet). Canal dry at various times.

1913–1917: Maximum and minimum stages were those of 1917.

ICE.—Stage-discharge relation unaffected; no water carried during extremely cold weather.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Revision of curve above 60 second-feet necessitated by measurements at higher stage. Gage read to half-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records excellent for irrigating season and good for the rest of the year.

Swalley canal diverts water from the right bank of Deschutes River at the North canal dam in the NE. ¼ sec. 29 and irrigates the Carey Act segregation of the Deschutes Reclamation & Irrigation Co., north of Bend and west of the Pilot Butte tract.

Discharge measurements of Swalley canal near Bend, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 20	Batchelder and Reineking	1.81	65	May 31	Briggs and Batchelder	1.78	63
Apr. 11	C. L. Batchelder	1.04	25.4	June 13	R. C. Briggs	1.78	65
May 29	do	[a] 1.28	32.5	Aug. 14	do	2.21	96

[a] Stage-discharge relation may have been temporarily affected by obstruction in the canal.

Digitized by Google

Daily discharge in second-feet of Swalley canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	65	62	7.5	7.5	7.5	23	18	43	72	68	94	72
2	65	62	4.0	7.5	7.5	23	18	43	62	72	90	68
3	65	62	7.5	7.5	7.5	23	23	43	.....	72	94	72
4	65	62	7.5	7.5	7.5	18	26	43	.....	76	90	72
5	65	62	7.5	7.5	7.5	18	26	43	9.5	72	86	72
6	65	62	7.5	7.5	7.5	18	26	43	.....	72	94	68
7	65	62	7.5	7.5	7.5	18	26	43	43	76	94	68
8	65	62	7.5	7.5	7.5	18	23	43	43	86	94	68
9	65	62	7.5	7.5	7.5	18	23	43	56	82	90	68
10	65	62	7.5	7.5	7.5	18	23	43	65	94	90	68
11	65	62	7.5	7.5	23	14	23	43	65	86	90	72
12	65	.....	7.5	7.5	23	14	23	43	65	82	94	68
13	65	.....	7.5	7.5	23	14	23	43	65	86	94	68
14	65	.....	7.5	7.5	23	12	23	43	62	82	90	68
15	65	.....	7.5	7.5	23	12	23	43	62	86	94	68
16	65	.....	7.5	7.5	23	12	23	43	62	86	94	68
17	65	.....	7.5	7.5	23	12	23	43	53	86	76	72
18	65	.....	7.5	7.5	23	14	23	43	65	82	76	72
19	65	7.5	7.5	7.5	23	14	23	43	65	79	76	68
20	65	7.5	7.5	7.5	23	14	23	43	65	86	79	65
21	65	7.5	7.5	7.5	23	14	23	43	65	86	76	65
22	62	7.5	7.5	7.5	23	14	23	43	72	86	65	65
23	62	7.5	7.5	7.5	23	14	23	43	68	86	65	62
24	62	7.5	7.5	7.5	23	14	26	43	68	86	65	65
25	62	7.5	7.5	7.5	23	18	26	43	72	86	65	65
26	62	7.5	7.5	7.5	23	18	26	43	79	86	65	62
27	62	7.5	7.5	7.5	23	18	26	43	72	94	65	65
28	62	7.5	7.5	7.5	23	18	28	43	72	94	65	65
29	62	7.5	7.5	7.5	.....	18	28	38	72	94	65	65
30	62	7.5	7.5	7.5	.....	18	36	36	72	94	72	65
31	62	.....	7.5	7.5	.....	18	.....	65	.....	94	72	.....

NOTE.—No flow during periods for which no discharge is given.

Monthly discharge of Swalley canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	65	62	64.0	3,940
November (23 days)	62	7.5	33.6	1,530
December	7.5	4	7.39	454
January	7.5	7.5	7.50	461
February	23	7.5	17.4	966
March	23	12	16.4	1,010
April	36	18	24.2	1,440
May	65	36	43.3	2,660
June (27 days)	79	9.5	62.6	3,350
July	94	68	83.8	5,150
August	94	65	81.3	5,000
September	72	62	67.6	4,020
The year	.....	.....	.....	30,000

TUMALO CREEK NEAR BEND, OREG.

LOCATION.—In SE. ¼ sec. 23, T. 17 S., R. 11 E., a quarter of a mile above diversion dam of feed canal of Tumalo project, half a mile below highway bridge on Bend-Sisters road. 4 miles above mouth, and 4 miles northwest of Bend, Deschutes County.

DRAINAGE AREA.—57 square miles.

RECORDS AVAILABLE.—October 6, 1906, to September 30, 1917. Until May, 1914, this station was maintained only in winter.

Digitized by Google

GAGE.—Since April 27, 1915, Stevens' continuous water-stage recorder referred to vertical staff nailed to overhanging stump. Staff gage read November, 1910, to April 26, 1915. Observers, T. G. Becker and F. H. Dayton. Previous records at different site.

DISCHARGE MEASUREMENTS.—At ordinary stages, made by wading near the gage; at flood stages, from a large tree fallen across stream about 200 yards below gage.

CHANNEL AND CONTROL.—Rocks and gravel; not likely to shift greatly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.58 feet at 10 p. m. June 16 (discharge, 417 second-feet); minimum stage recorded 0.98 foot at 7 a. m. March 20 (discharge, 31 second-feet).

1906–1917: Maximum stage recorded, 3.8 feet at old gage, November 14, 1906 (discharge, estimated from extension of rating curve, 820 second-feet). The peak of the flood of November, 1909, was probably considerably greater. Minimum stage recorded was that of 1917.

ICE.—Stage-discharge relation considerably affected by ice during extremely cold weather.

DIVERSIONS.—Columbia southern canal and Anderson ditch divert water above the station. Water was diverted into Columbia southern canal continuously beginning October 24, to supply water for sawmill of Pine Tree Lumber Co. Meter measurements were made as follows:

	Second-feet.
At former gaging station near intake: June 1	33.6
At mill:	
June 1	21.6
Aug. 21	5.6

From these measurements and information furnished by Fred N. Wallace, project manager, and by the observer on Tumalo Creek, monthly diversion has been estimated for the purpose of determining the total flow of Tumalo Creek. From August 13 to September 30 water was diverted into the head of Tumalo Creek from Crater Creek, a tributary of Deschutes River. Discharge measured at an 8-foot Cippoletti weir at the divide where the waters pass into the Tumalo Creek drainage basin is given in a following table.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice for various periods, November to March. Rating curve well defined between 45 and 250 second-feet. Curve used is a revision of that used for 1916. Operation of water-stage recorder satisfactory from June 1 to September 30; previous to June 1 intake to well was stopped up and two readings a day on outside staff gage were made. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting gage-height graph or by averaging the two daily gage readings. Records good, except for periods when stage-discharge relation was affected by ice as shown in footnote to table of daily discharge.

Discharge measurements of Tumalo Creek near Bend, Oreg. during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 17	Batchelder and Reineking.	1.38	[a] 63	June 1	Batchelder and Briggs	1.86	178
				Aug. 16	R. C. Briggs	1.45	100
Apr. 11	C. L. Batchelder	1.17	44.9	16	do	1.45	[a] 89.3
May 1	F. F. Henshaw	1.35	[a] 64.5				

[a] Measured in feed canal.

Digitized by Google

Daily discharge, in second-feet, of Tumalo Creek near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	70	60	60	60	60	57	38	60	194	208	98	70
2	70	70	60	60	60	58	40	62	181	252	98	77
3	67	77	63	60	60	59	37	65	168	282	98	74
4	67	74	62	60	60	60	38	67	163	282	92	68
5	67	60	63	60	60	60	44	70	181	282	85	67
6	67	60	62	62	60	58	40	85	208	267	81	70
7	67	60	62	60	58	56	45	90	252	252	81	67
8	67	60	62	60	56	40	44	88	252	252	74	63
9	67	60	61	60	54	42	42	107	208	267	77	63
10	67	60	61	60	54	42	42	120	237	252	81	67
11	67	60	61	60	54	41	46	139	194	267	65	65
12	67	59	61	60	53	41	45	151	194	267	65	63
13	67	59	60	60	51	41	51	144	194	237	72	65
14	65	58	62	60	49	41	53	146	222	208	88	63
15	65	57	60	60	49	40	53	149	267	252	83	63
16	68	57	58	60	49	40	51	130	315	252	83	65
17	68	56	59	60	44	40	49	122	332	252	88	67
18	68	55	60	60	49	40	49	111	315	237	85	67
19	68	54	60	60	47	39	49	102	332	222	77	62
20	68	54	54	60	48	31	51	100	315	194	77	60
21	68	53	60	60	49	36	49	96	332	168	85	58
22	67	52	60	60	50	39	52	94	298	168	79	56
23	67	52	60	60	51	38	60	102	267	194	75	57
24	46	51	60	60	52	38	62	105	252	161	79	51
25	48	67	60	60	53	38	72	100	237	139	77	50
26	54	62	60	60	54	38	81	107	237	149	77	52
27	56	70	60	60	55	45	77	116	237	144	67	56
28	56	67	60	60	56	45	70	139	252	125	63	58
29	58	60	60	60	.....	42	68	181	237	111	63	58
30	58	60	60	60	.....	39	63	181	208	100	70	59
31	60	.....	60	60	.....	38	.....	181	.....	100	70	.....

NOTE.—Stage-discharge relation affected by ice Nov. 12-23; Dec. 6-12, 15, 24-31; Jan. 1-4, 12-27, 30, 31; Feb. 1-3, 20-28; Mar. 1-3, 6, 11-17, and 31; discharge estimated. Discharge interpolated Oct. 20-22.

Monthly discharge of Tumalo Creek near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	70	46	64.0	3,940
November	77	51	60.1	3,580
December	63	54	60.4	3,710
January	62	60	60.1	3,700
February	60	44	53.4	2,970
March	60	31	43.9	2,700
April	81	37	52.0	3,090
May	181	60	113	6,950
June	332	163	246	14,600
July	282	100	211	13,000
August	98	63	79.1	4,900
September	77	50	62.7	3,730
The year	332	31	92.3	66,900

Digitized by Google

Daily discharge, in second-feet, of Crater Creek near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Aug.	Sept.	Day.	Aug.	Sept.	Day.	Aug.	Sept.
1	.....	20.0	11	.....	8.5	21	24.3	8.5
2	.....	17.3	12	.....	8.5	22	21.8	8.5
3	.....	14.4	13	24.9	8.5	23	22.5	8.5
4	.....	14.4	14	24.7	8.5	24	21.1	8.5
5	.....	14.1	15	22.5	8.5	25	17.6	8.5
6	.....	13.7	16	21.9	8.5	26	15.6	8.5
7	.....	9.9	17	22.4	8.5	27	15.6	8.5
8	.....	10.6	18	20.6	8.5	28	17.3	8.5
9	.....	11.3	19	19.7	8.5	29	17.3	8.5
10	.....	8.5	20	22.6	8.5	30	17.4	8.5
						31	20.2	.....

NOTE.—Discharge estimated for the period Sept. 11 to Sept. 30.

Monthly discharge of Tumalo Creek and Columbia Southern canal less Crater Creek near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.					Run-off (total in acre-feet).
	Tumalo Creek.	Canal.	Total.	Crater Creek.	Difference.	
October	64.0	3.9	67.9	0	67.9	4,180
November	60.1	11.6	71.7	0	71.7	4,270
December	60.4	0	60.4	0	60.4	3,710
January	60.1	0	60.1	0	60.1	3,700
February	53.4	8.6	62.0	0	62.0	3,440
March	43.9	15.0	58.9	0	58.9	3,620
April	52.0	15.0	67.0	0	67.0	3,990
May	113	20.0	133	0	133	8,180
June	246	47.0	293	0	293	17,400
July	211	55.0	266	0	266	16,400
August	79.1	15.0	94.1	12.6	81.5	5,010
September	62.7	15.0	77.7	10.1	67.6	4,020
The year	92.3	17.2	109	.....	107	77,900

TUMALO FEED CANAL NEAR BEND, OREG.

LOCATION.—In SE. ¼ sec. 23, T. 17 S., R. 11 E., in concrete-lined section, about 300 feet below diversion dam, half a mile below bridge across Tumalo Creek on road from Bend to Sisters, and 4 miles from Bend, Deschutes County.

RECORDS AVAILABLE.—May 21, 1914, when water was first diverted, to September 30, 1917.

GAGE.—Painted on sloping concrete lining. Gage readers, T. G. Becker and F. H. Dayton.

DISCHARGE MEASUREMENTS.—Made from a footbridge at gage.

CHANNEL AND CONTROL.—Trapezoidal concrete section; the control is the sand trap just above the intake to a steel flume.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.30 feet June 2 to July 20 (discharge, 148 second-feet). Canal dry at various times.

1914–1917: Maximum stage recorded, 3.80 feet May 4, 5, and 6, 1916 (discharge, 219 second-feet).

ICE.—Water has to be turned out in extremely cold weather.

ACCURACY.—Stage-discharge relation changed in March by work on canal below station; affected by ice at times during December (see footnote to table of daily discharge). Rating curve used October 1 to March 15 fairly well defined; curve used March 16 to September 30 well defined between 40 and 150 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good October to March; excellent for the rest of year.

Tumalo feed canal diverts water from Tumalo Creek in the SE. ¼ sec. 23, T. 17 S., R. 11 E., into the Tumalo project reservoir. Some land is also watered directly from the canal.

Digitized by Google

Discharge measurements of Tumalo feed canal near Bend, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 17	Batchelder and Reineking	2.51	63	June 1	Briggs and Batchelder	3.10	132
May 1	F. F. Henshaw	2.40	64	Aug. 16	R. C. Briggs	2.74	89

Daily discharge, in second-feet, of Tumalo feed canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	74	56	59	.....	.....	.....	30	64	136	148	96	72
2	70	66	59	13	.....	.....	30	64	148	148	96	76
3	70	70	62	19	5	.....	28	68	148	148	96	72
4	66	66	59	19	15	17	28	72	148	148	92	68
5	70	59	62	19	17	17	37	72	148	148	88	68
6	66	59	60	23	21	6	34	88	148	148	80	72
7	66	59	60	12	28	17	41	88	148	148	80	68
8	66	59	60	8	52	17	37	84	148	148	76	64
9	66	59	60	19	52	4	34	106	148	148	76	64
10	66	59	60	34	52	.....	16	111	148	148	72	68
11	66	59	60	59	52	.....	.....	131	148	148	72	64
12	66	52	60	42	52	.....	.....	136	148	148	72	64
13	66	24	59	.....	49	.....	16	131	148	148	72	64
14	66	.....	56	.....	46	.....	47	131	148	148	88	60
15	66	.....	56	.....	46	.....	47	111	148	148	88	64
16	66	35	56	.....	46	15	44	80	148	148	88	64
17	66	17	58	.....	35	15	44	80	148	148	92	64
18	66	17	59	.....	46	15	44	80	148	148	92	64
19	66	17	59	.....	40	17	44	80	148	148	84	64
20	66	17	52	.....	46	12	47	80	148	148	84	64
21	66	17	59	.....	38	19	44	80	148	142	88	64
22	66	20	59	19	35	28	50	80	148	136	88	56
23	66	21	59	21	38	23	64	80	148	148	80	56
24	40	23	59	21	40	26	64	80	148	136	80	53
25	43	26	59	21	23	27	76	101	148	126	80	53
26	52	59	59	21	.....	27	84	106	148	131	80	56
27	49	66	59	21	.....	38	80	116	148	131	72	56
28	52	62	42	23	.....	38	72	136	148	121	64	60
29	56	59	.....	23	.....	34	72	136	148	106	68	60
30	56	59	.....	6	.....	32	68	136	148	96	72	60
31	56	.....	.....	.....	.....	41	.....	136	.....	96	68	.....

NOTE.—Stage-discharge relation affected by ice and daily discharge estimated Dec. 6–12, 15, and 24–28. No gage readings Jan. 2, 3, 22–26, Mar. 4–9, 16, and 17; discharge estimated from observer's notes. Discharge interpolated Oct. 20–22 and Aug. 4. Canal dry on days for which no discharge is given.

Monthly discharge of Tumalo feed canal near Bend, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	74	40	62.6	3,850
November (28 days)	70	17	45.1	2,500
December (28 days)	62	42	58.2	3,230
January (20 days)	59	6	22.2	881
February (23 days)	52	5	38.0	1,730
March (22 days)	41	4	22.0	960
April (28 days)	84	16	47.2	2,620
May	136	64	98.2	6,040
June	148	136	148	8,810
July	148	96	140	8,610
August	96	64	81.4	5,010
September	76	53	63.4	3,770
The year	.....	.....	.....	48,000

Digitized by Google

SQUAW CREEK NEAR SISTERS, OREG.

LOCATION.—In NW. ¼ sec. 32, T. 15 S., R. 10 E., immediately above intake of McCallister ditch and about 5miles by road above Sisters, Deschutes County.

DRAINAGE AREA.—63 square miles.

RECORDS AVAILABLE.—May 30, 1913, to September 30, 1917; no winter records. From July 1, 1906, to May 23, 1913, in sec. 29, at station below the intake of McCallister ditch, about 700 feet farther downstream.

GAGE.—Stevens eight-day water-stage recorder on right bank; inspected by A. E. Perry, deputy water master. Vertical staff read prior to 1916.

DISCHARGE MEASUREMENTS.—Made from a cable about 100 yards above gage, or by wading.

CHANNEL AND CONTROL.—Gravel and boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.47 feet at 10 p. m., July 18 (discharge, 518 second-feet); minimum stage recorded, 1.77 feet at 12 midnight, April 6 (discharge, 38 second-feet).

1906–1917: Maximum stage recorded, 7.5 feet at old station, November 22, 1909 (discharge estimated from extension of rating curve as 1,940 second-feet); minimum stage recorded, 2.65 feet at old station, March 19, 1912 (discharge, 32 second-feet).

DIVERSIONS.—Pole Creek, a tributary of Squaw Creek from the west, has been diverted for irrigation. The diversion canal has been eroded until it carries the entire flow of this creek. Low-water flow entirely diverted below the station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during high water in July. Rating curve used October 1 to July 16 well defined between 70 and 400 second-feet; curve used July 20 to September 30 fairly well defined between 50 and 450 second-feet. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting recorder graph. Shifting-control method used July 17–19. Records good.

Discharge measurements of Squaw Creek near Sisters, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 18	Batchelder and Reineking	2.05	72	Aug. 9	Perry and Cox [b]	2.66	204
July 10	Perry [a] and Brewster [b]	3.10	394	18	Briggs and Cox	2.58	172
31	A. E. Perry	2.71	211	Sept. 2	Perry and Cox	2.56	181
				30	do	2.30	108

[a] Water master.

[b] Manager Squaw Creek Irrigation Co.

Digitized by Google

Daily discharge, in second-feet, of Squaw Creek near Sisters, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	90	.....	.....	68	161	268	240	158
2	77	.....	.....	68	144	302	240	172
3	71	.....	.....	71	133	302	240	183
4	71	.....	.....	72	133	339	240	158
5	70	.....	41	77	147	339	210	142
6	68	.....	39	77	164	358	198	138
7	66	57	48	88	188	358	192	138
8	65	51	49	88	218	377	186	130
9	64	.....	44	98	250	415	195	121
10	62	.....	43	115	218	396	180	119
11	61	.....	49	141	185	396	170	108
12	.....	.....	46	150	173	396	175	108
13	.....	.....	44	147	170	396	183	104
14	.....	.....	43	150	188	358	186	100
15	.....	.....	42	138	218	415	180	108
16	.....	.....	41	122	268	472	183	115
17	.....	.....	41	115	285	470	192	119
18	72	.....	40	100	285	460	186	115
19	70	.....	43	95	302	450	178	112
20	68	.....	44	88	302	410	178	110
21	68	.....	45	90	302	350	195	96
22	64	.....	60	85	302	330	172	84
23	62	.....	66	92	285	310	165	83
24	62	.....	72	100	285	292	170	77
25	.....	.....	90	95	268	275	175	94
26	.....	.....	85	98	285	292	160	102
27	.....	.....	80	115	285	275	155	102
28	.....	.....	76	136	302	258	142	108
29	.....	.....	72	152	285	240	148	115
30	.....	.....	70	155	268	225	152	112
31	.....	.....	.....	158	.....	225	148	.....

Monthly discharge of Squaw Creek near Sisters, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
April 5-30	90	39	54.3	2,800
May	158	68	108	6,640
June	302	133	233	13,900
July	472	225	347	21,300
August	240	142	184	11,300
September	183	77	118	7,020
The period	.....	.....	.....	63,000

SQUAW CREEK CANAL NEAR SISTERS, OREG.

LOCATION.—In SW. ¼ sec. 28, T. 15 S., R. 10 E., about half a mile below intake and about 4 miles by road south of Sisters, Deschutes County.

RECORDS AVAILABLE.—April 26 to September 11, 1916; April 30 to September 30, 1917.

GAGE.—Stevens 8-day water-stage recorder on right side of canal, a short distance below a wasteway; inspected by A. E. Perry.

DISCHARGE MEASUREMENTS.—Made by wading near gage.

CHANNEL AND CONTROL.—Channel is excavated in a gravelly soil; not likely to shift; a timber placed across canal just below gage forms a control for low water but has little effect at ordinary stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during 1916-1917, 2.22 feet at 5 p. m. July 10, 1917 (discharge, 182 second-feet); canal dry during winter.

Digitized by Google

ACCURACY.—Stage-discharge relation changed during winter. Rating curve used April 30 to September 30 well defined between 60 and 180 second-feet and fairly well defined below 60 second-feet. Water-stage recorder operated satisfactorily. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting the gage-height graph. Records excellent for June, July, and August; good for May and September.

Squaw Creek canal diverts water from Squaw Creek in the SE. ¼ sec. 29, T. 15 S., R. 10 E., and irrigates land east and north of Sisters; 8.328 acres have been adjudicated a water right under it, but only about 4.900 acres were irrigated in 1916.

Discharge measurements of Squaw Creek canal near Sisters, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
July 10	Perry [a] and Brewster [b]	2.15	169	Aug. 14	Perry and Cox [b]	1.59	77
Aug. 10	Perry and Cox [b]	1.70	94	18	R. C. Briggs	1.60	80

[a] Water master. [b] Manager Squaw Creek Irrigation Co.

Daily discharge, in second-feet, of Squaw Creek canal near Sisters, Oreg., for the year ending Sept. 30, 1917.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	26	55	126	121	64	16	48	141	146	88	48
2	34	51	145	126	66	17	44	128	150	86	50
3	36	50	83	131	64	18	38	116	160	80	49
4	36	55	97	124	55	19	38	115	157	80	51
5	36	69	116	115	53	20	37	134	146	84	56
6	39	86	133	113	49	21	37	145	155	94	49
7	27	94	148	116	48	22	37	121	143	90	40
8	20	99	143	113	44	23	36	99	138	91	36
9	22	96	155	113	46	24	37	97	124	97	32
10	36	80	169	104	45	25	38	97	115	102	37
11	48	73	169	94	45	26	41	104	134	80	40
12	50	79	157	97	43	27	43	107	100	90	41
13	49	88	150	100	43	28	48	118	128	62	42
14	49	97	152	102	43	29	55	126	116	64	44
15	50	120	157	91	45	30	51	123	116	65	43
						31	56	.....	120	65	.....

Monthly discharge of Squaw Creek canal near Sisters, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
May	56	20	40.1	2,470
June	145	50	98.8	5,880
July	169	83	137	8,420
August	131	62	96.1	5,910
September	66	32	47.0	2,800
The period	.....	.....	.....	25,500

Digitized by Google

OCHOCO CREEK AT ELLIOTT RANCH, NEAR PRINEVILLE, OREG.

LOCATION.—In NE. ¼ sec. 5, T. 15 S., R. 17 E., at dam site of proposed reservoir for Ochoco project, below all tributaries, 6½ miles east of Prineville, Crook County, on road to Mitchell.

DRAINAGE AREA.—300 square miles.

RECORDS AVAILABLE.—November 1, 1908, to April 30, 1910; November 23, 1914, to June 30, 1915; January 21, 1916, to September 30, 1917.

GAGE.—Stevens 8-day water-stage recorder on left bank since April 21, 1916; inspected by Harry G. Kennard, water master. Vertical staff up to that time.

DISCHARGE MEASUREMENTS.—Made from cable at gage or by wading.

CHANNEL AND CONTROL.—Gravel and boulders; somewhat shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.12 feet at 10 a. m. April 26 (discharge, 930 second-feet); minimum stage recorded 0.58 foot September 13 and 21 (discharge, 1.4 second-feet).

1908–1910, and 1915–1917: Maximum stage recorded, 4.50 feet at 4 p. m. November 23, 1909 (discharge, 1,160 second-feet). Creek dry at various times on account of diversions above.

ICE.—Stage-discharge relation slightly affected during cold weather.

DIVERSIONS.—Considerable land irrigated along Ochoco Creek and tributaries above the station. Tableland and Elliott ditches divert water around the station. (See pp. 57–58.)

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed slightly. Rating curve fairly well defined between 4 and 400 second-feet. Operation of water-stage recorder satisfactory except for breaks in record indicated in footnote to table of daily discharge. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting the gage-height graph, except for March 27–29, for which days the discharge given is the average of discharge determined for shorter intervals. Records good March to May; fair October, November, February, and June; poor for the remainder of year.

Discharge measurements of Ochoco Creek at Elliott ranch, near Prineville, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Mar. 29	H. G. Kennard [a]	1.72	116	June 6	Briggs and Kennard	1.84	150
Apr. 19	do	1.96	166	Aug. 13	do	.65	2.1

[a] Water master.

Digitized by Google

Daily discharge, in second-feet, of Ochoco Creek at Elliott ranch, near Prineville, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4.6	6.7	.....	.....	11	69	424	236	.....	.....	2.2
2	4.6	6.7	.....	.....	11	76	382	215	.....	.....	2.2
3	4.6	6.4	.....	.....	15	60	430	195	.....	.....	2.0
4	4.6	7.3	.....	.....	14	96	424	180	.....	.....	1.8
5	4.6	8.2	.....	.....	18	162	441	162	.....	.....	1.6
6	4.6	8.5	.....	.....	13	180	483	145	.....	.....	1.5
7	5.2	8.5	.....	.....	14	269	567	.....	.....	.....	1.5
8	5.5	8.8	.....	.....	15	466	546	.....	.....	.....	1.4
9	5.5	9.4	.....	.....	15	354	581	.....	.....	.....	1.4
10	5.5	9.7	.....	.....	14	302	630	.....	.....	.....	1.4
11	5.2	10	.....	.....	12	385	658	.....	9.1	.....	1.5
12	5.2	9.1	.....	16	11	382	730	.....	8.8	.....	1.5
13	4.9	10	.....	14	13	317	726	84	8.5	2.8	1.4
14	4.9	7.9	9.4	12	14	311	654	75	8.2	2.8	1.4
15	4.9	8.2	9.7	17	12	260	595	54	7.9	2.8	1.4
16	4.9	7.9	10	26	11	236	500	.....	7.6	2.8	1.4
17	4.9	.....	11	19	11	202	462	.....	7.3	3.8	1.4
18	4.9	.....	11	17	12	182	434	.....	7.0	3.0	1.4
19	4.9	.....	10	18	15	171	385	.....	.....	2.8	1.4
20	4.9	.....	11	18	15	192	368	30	.....	2.8	1.4
21	4.9	.....	11	16	15	242	350	.....	.....	2.8	1.4
22	.....	.....	.....	15	16	293	320	.....	.....	3.8	1.5
23	.....	.....	.....	16	17	458	228	.....	.....	2.8	2.5
24	.....	.....	.....	15	35	609	215	.....	.....	2.8	2.8
25	.....	.....	.....	15	45	710	208	.....	.....	2.8	2.5
26	7.0	.....	.....	12	33	826	198	.....	.....	2.8	2.5
27	7.0	.....	.....	12	173	702	212	.....	.....	2.8	2.2
28	6.7	.....	.....	14	175	626	230	.....	.....	2.8	2.2
29	6.7	.....	.....	.....	141	553	263	.....	.....	2.8	2.2
30	6.7	.....	.....	.....	78	483	263	.....	4.6	2.8	2.2
31	6.7	.....	.....	.....	60	.....	257	.....	4.0	2.5	.....

NOTE.—Daily discharge estimated as follows: Oct. 22–25, 6 second-feet; Nov. 17–30, 8 second-feet; Dec. 1–13, 9 second-feet; Dec. 22–31, 10 second-feet; Feb. 1–11, 12 second-feet; May 20–22, as given in table; June 7–12, 100 second-feet; June 16–19, 40 second-feet; June 21–30, 18 second-feet; July 1–10, 12 second-feet; July 19–29, 6 second-feet; Aug. 1–12, 3 second-feet. Discharge interpolated Mar. 21, 22, June 5, July 12–17, Aug. 21–26, Sept. 5, 14–20 and 28–30.

Monthly discharge of Ochoco Creek at Elliott ranch, near Prineville, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	.....	4.6	5.44	334
November	10	6.4	8.18	487
December	.....	.....	9.68	595
January	.....	.....	[a] 10.0	615
February	26	.....	14.4	799
March	175	11	34.0	2,090
April	826	60	339	20,200
May	730	198	425	26,100
June	236	.....	77.2	4,590
July	.....	4.0	8.35	513
August	.....	2.5	2.91	179
September	2.8	1.4	1.77	105
The year	826	1.4	78.2	56,600

[a] Estimated.

Digitized by Google

Combined monthly discharge of Ochoco Creek at Elliott ranch, Tableland and Elliott ditches near Prineville, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October		4.6	5.44	334
November	10	6.4	8.18	487
December			9.68	595
January			[a] 10.0	615
February	27		15.0	833
March	181	12	35.6	2,190
April	847	69	356	21,200
May	752	215	445	27,400
June	254		97.2	5,780
July		6.0	10.4	640
August		2.5	2.91	179
September	2.8	1.4	1.77	105
The year				60,400

[a] Estimated.

TABLELAND DITCH NEAR PRINEVILLE, OREG.

LOCATION.—In NW. ¼ sec. 5, T. 15 S., R. 16 E., at Elliott's ranch, about 1½ miles below intake, quarter of a mile upstream from station on Ochoco Creek, and about 6½ miles east of Prineville, Crook County.

RECORDS AVAILABLE.—Irrigating seasons 1915 to 1917.

GAGE.—Vertical staff on right bank just below a wasteway from which the surplus flow is returned to the creek. Datum 3.0 feet lower than that used in 1915. Gage reader, S. B. Anderson.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Ditch is well made in solid material and shifts only slightly; no defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.33 feet May 23 (discharge, 19.1 second-feet); ditch dry at times.

1915–1917: Maximum stage recorded, 5.4 feet February 26 to March 1, 1915, and March 20 and 26–30, 1916 (discharge, 20 second-feet).

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Gage read to tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good. Some uncertainty as to date at which water was turned in.

Tableland ditch diverts water from the right bank of Ochoco Creek in the NW. ¼ sec. 4, T. 15 S., R. 16 E., and extends northwestward for about 8 miles, irrigating about 1,400 acres of bench land lying north of Ochoco Creek and Crooked River.

Discharge measurements of Tableland ditch near Prineville, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
May 23	H. G. Kennard [a]	5.33	18.7
June 5	Briggs and Kennard	5.11	14.8

[a] Water master.

Digitized by Google

Daily discharge, in second-feet, of Tableland ditch near Prineville, Oreg., for the year ending Sept. 30, 1917.

Day.	Mar.	Apr.	May.	June.	Day.	Mar.	Apr.	May.	June.
1			18	14	16		16	18	18
2		3.4	18	14	17		10	18	18
3		11	18	14	18		12	18	18
4		12	18	14	19		12	18	18
5		1.3	18	14	20		16	18	18
6		12	18	14	21		16	18	18
7		14	18	14	22		16	18	18
8		14	18	16	23		18	18	18
9		14	18	18	24		18	18	18
10		14	18	18	25		18	14	18
11		16	18	18	26		18	14	18
12		16	18	18	27		18	14	11
13		16	18	18	28	6.0	18	14	
14		16	18	18	29	9.0	18	14	
15		16	18	18	30	9.0	18	16	
					31	9.0		14	

Monthly discharge of Tableland ditch near Prineville, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
March (4 days)	9.0	6.0	8.25	65
April (29 days)	18	1.3	14.4	828
May	18	14	17.2	1,060
June (27 days)	18	11	16.6	889
The year				2,840

ELLIOTT DITCH NEAR PRINEVILLE, OREG.

LOCATION.—In NE. ¼ sec. 5, T. 15 S., R. 17 E., about 200 yards below intake, opposite gage on Ochoco Creek, and 6½ miles east of Prineville, Crook County.

RECORDS AVAILABLE.—November 1, 1908, to April 30, 1910, and October 26, 1914, to June 29, 1917, with some gaps.

GAGE.—Vertical staff driven in the right bank of canal; different gage was used 1908 to 1910. Gage reader, H. G. Kennard.

DISCHARGE MEASUREMENTS.—Made by wading or from a foot plank near the gage.

CHANNEL AND CONTROL.—Ditch flat and badly silted; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and during 1908–1910, and 1915–1917, 2.2 feet on June 25 (discharge, 13 second-feet). Canal dry at various times.

ICE.—Stage-discharge relation affected by ice at times.

ACCURACY.—Stage-discharge relation changed during winter. Rating curve poorly defined. Gage read to half-tenths on days for which discharge is given. Discharge ascertained by applying gage height to rating tables except March 13 for which it has been estimated on account of ice. Records poor but are of value in determining the total flow of Ochoco Creek.

Elliott ditch diverts from the left bank of Ochoco Creek and irrigates 160 acres of land, mostly in alfalfa. Probably a considerable part of the water returns to the stream a short distance below.

Digitized by Google

Discharge measurements of Elliott ditch near Prineville, Oreg., during the year ending Sept. 30, 1917.

[Made by H. G. Kennard, water master.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
May 22	1.12	1.9
June 25	2.05	10.7
25	1.55	4.9

Discharge, in second-feet, of Elliott ditch near Prineville, Oreg., for the year ending Sept. 30, 1917.

Date.	Discharge.	Date.	Discharge.	Date.	Discharge.
Feb. 19	1.1	Mar. 29	0.0	June 4	2.6
26	1.3	Apr. 27	3.4	5	2.0
Mar. 6	.8	May 12	3.7	25	8.3
13	.8	22	1.9	26	4.5
22	.5	29	5.0	28	3.6
				29	3.4

Monthly discharge of Elliott ditch near Prineville, Oreg., for the year ending Sept. 30, 1917.

Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).	Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).
February (14 days)	1.2	33	June	5.0	298
March (25 days)	.7	35	July	2.0	123
April (25 days)	3.0	149			
May	3.5	215	The period		853

NOTE.—Mean discharge estimated from fragmentary gage height record and notes by water master.

METOLIUS RIVER AT ALLINGHAM RANGER STATION, NEAR SISTERS, OREG.

LOCATION.—In NE. ¼ sec. 3, T. 13 S., R. 9 E., at Allingham ranger station, in Jefferson County, 1½ miles below mouth of Lake Creek, 3 miles below head of river, and about 17 miles northwest of Sisters.

DRAINAGE AREA.—50 square miles.

RECORDS AVAILABLE.—September 15, 1910, to October 31, 1913; June 21 to September 30, 1915; May 16 to September 16, 1916; July 1 to September 14, 1917, when station was discontinued.

GAGE.—Vertical staff on left bank 100 yards below bridge at ranger station. Gage reader, L. W. Zumwalt.

DISCHARGE MEASUREMENTS.—Made by wading near gage.

CHANNEL AND CONTROL.—Gravel.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 0.91 foot May 30 (discharge, 460 second-feet); minimum stage recorded, 0.52 foot, January 12 (discharge, 304 second-feet).

1910–1913 and 1915–1917: Maximum stage recorded, 0.97 foot, February 16, 1912 (discharge, 566 second-feet); minimum stage recorded, 0.40 foot, September 28, 1915 (discharge, 264 second-feet).

ICE.—Stage-discharge relation unaffected by ice, as water comes from springs.

DIVERSIONS.—Practically none.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Gage read to hundredths occasionally between July 1 and September 14. Daily discharge ascertained by applying daily gage height to rating table. Records excellent for days on which gage was read.

Digitized by Google

Discharge measurements of Metolius River at Allingham ranger station, near Sisters, Oreg., Oct. 17, 1916, to Oct. 16, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 17	Batchelder and Reineking	0.52	305
May 30	Perry and Batchelder	.91	449
Oct. 16	Batchelder and Briggs	.60	333

Daily discharge, in second-feet, of Metolius River at Allingham ranger station, near Sisters, Oreg., for the year ending Sept. 30, 1917.

Day.	Jan.	May.	July.	Aug.	Sept.	Day.	Jan.	May	July.	Aug.	Sept.
1			419	362		16				330	
2						17			378		
3			410			18				330	
4				362	338	19					
5						20					
6			406			21			370		
7				350		22					
8			410			23			366		
9						24					
10			390	330	338	25			366		
11						26					
12	304		382		350	27					
13				330		28			362		
14			382		350	29					
15						30		460	362		
						31					

LAKE CREEK NEAR SISTERS, OREG.

LOCATION.—In SE. ¼ sec. 24, T. 13 S., R. 8 E., in Jefferson County, a quarter of a mile below outlet of Suttle Lake, 6 miles from mouth of creek, and about 15 miles northwest of Sisters.

DRAINAGE AREA.—20.5 square miles.

RECORDS AVAILABLE.—May to November, 1911; March to September, 1912; May to October, 1913, occasional readings; April 7, 1915, to September 30, 1917.

GAGE.—Vertical staff on left bank; gage about 20 feet above a 15-foot weir read April 7, 1915, to April 30, 1916. Gage in natural channel, near site of weir, used 1911 to 1913. Gage readers, Harry Heising and Wm. Heathman.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Heavy gravel and boulders; practically permanent.

EXTREMES OF DISCHARGE.—1911–1913 and 1915–1917: Maximum stage recorded, 1.60 feet May 27, 1917 (discharge, 146 second-feet). Minimum stage recorded, 0.31 foot October 18, 1916 (discharge, 20 second-feet).

ICE.—Stage-discharge relation unaffected.

DIVERSIONS.—None above station; one small ditch takes out of Lake Creek.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve fairly well defined between 20 and 150 second-feet. Gage read to quarter-tenths about once a week October to June 17; to hundredths daily thereafter. Daily discharge ascertained by applying daily gage height to rating table. No readings in April. Records fair, October to February and June; poor, March to May; good, July to September.

Digitized by Google

Discharge measurements of Lake Creek near Sisters, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 18	Batchelder and Reineking	0.31	18.9
May 30	Perry [a] and Batchelder	1.46	125
June 25	A. E. Perry	1.50	129

[a] Water master.

Daily discharge, in second-feet of Lake Creek near Sisters, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	May.	June.	July.	Aug.	Sept.
1					46	70			110	45	39
2									106	45	38
3				36					99	44	38
4					49		100		94	44	38
5			36						91	43	38
6				37					87	43	38
7		35			51				85	43	38
8	25			42					85	43	38
9								141	83	43	38
10					51				80	43	38
11				42			106		77	43	38
12			37				95		73	43	38
13					59				71	43	38
14				44					68	42	38
15	25	36							66	42	38
16					57				65	42	37
17				44				110	63	41	37
18	20							111	62	41	37
19								116	60	41	37
20			37	44			112	124	59	41	37
21	29	35			57			125	59	41	37
22							138	143	56	41	37
23				46	59			143	55	41	37
24						65		143	53	41	37
25						75		130	51	41	37
26				46	75			128	50	40	37
27			38				146	125	48	40	37
28		36				70		122	48	40	37
29	35			46				122	47	40	37
30							124	120	46	39	37
31						75			46	39	

Monthly discharge of Lake Creek near Sisters, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October			26.8	1,650
November			35.5	2,110
December			37.0	2,280
January			42.7	2,630
February			56.0	3,110
March			[a] 56.2	3,460
April			[a] 85.0	5,060
May			117	7,190
June			[a] 128	7,620
July	110	46	69.1	4,250
August	45	39	41.9	2,580
September	39	37	37.5	2,230
The year			61.1	44,200

[a] Estimated.

NOTE.—Monthly mean discharge, October to February and May is average of discharge for days on which gage was read.

Digitized by Google

FIRST CREEK NEAR SISTERS, OREG.

LOCATION.—In SW. ¼ sec. 12, T. 13 S., R. 8 E., in Jefferson County, just above a trail crossing 1½ miles from road leading to Suttle Lake, about 15 miles northwest of Sisters.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 7, 1915, to March 31, 1917, when station was discontinued.

GAGE.—Vertical staff on left bank about 5 feet above weir. Old gage read prior to April 2, 1916, was at a datum 5.08 feet higher. Gage reader, Harry Heising.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Control is a trapezoidal weir 14.8 feet long; crest rounded; considerable velocity of approach; not permanent on account of leakage under weir.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.4 feet December 27 (discharge, 10 second-feet). Minimum stage was recorded during period when stage-discharge relation was affected by ice (discharge estimated 0.1 second-foot).

1915–1917: Maximum stage recorded, 6.3 feet June 18 and 20, 1916 (discharge, 71 second-feet). Minimum stage recorded that of 1917.

ICE.—Stage-discharge relation occasionally affected.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not entirely permanent on account of leakage under the weir. Rating curve fairly well defined. Gage read to half-tenths about once a week. Discharge ascertained by applying daily gage heights to rating table. Records fair for October and November; poor for remainder of period.

The following discharge measurement was made by Batchelder and Reineking: October 18, 1916: Gage height, 5.21 feet; discharge 1.87 second-feet.

Daily discharge, in second-feet, of First Creek near Sisters, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1					0.2	0.2	16					5.0	
2							17				0.2		
3				5.0			18	1.8					
4					.2		19						
5			1.5				20			5.0	.2	.2	
6				5.0			21	1.5	1.5				
7		1.5			.4		22						
8	1.5			5.0			23				.2	.2	
9							24						0.2
10					.4		25						
11				5.0			26				.2	1.0	
12			5.0				27			10.0			
13					.2		28		1.5				
14				0.5			29	1.5			.2		
15	1.5	1.5					30						
							31						

NOTE.—Mean discharge estimated as 0.1 second-foot March 2 to 23; 5 second-feet March 25 to 31.

Digitized by Google

Monthly discharge of First Creek near Sisters, Oreg., for the year ending Sept. 30, 1917.

Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).	Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).
October	1.6	98	February	0.9	50
November	1.5	89	March	1.2	74
December	5.4	332			
January	2.2	135	The period		778

NOTE.—Monthly mean discharge is average of discharge for days on which gage was read, except that or March, which was estimated.

TROUT CREEK NEAR ANTELOPE, OREG.

LOCATION.—In NE. ¼ sec. 2, T. 9 S., R. 15 E., at J. H. Priday's ranch, about 2 miles above mouth of Antelope Creek, 15 miles east of Gateway, Jefferson County, and 16 miles southwest of Antelope, Wasco County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 24 to September 18, 1915; February 15, 1916, to July 14, 1917, when station was discontinued.

GAGE.—Vertical staff on right bank about 60 feet below a flume crossing and about 600 feet from Priday ranch house. Gage reader, Mrs. J. H. Priday.

DISCHARGE MEASUREMENTS.—Made by wading near gage.

CHANNEL AND CONTROL.—Stream bed of gravel and silt; one channel at all stages; no defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.0 feet at 9 p. m. March 27 (discharge, 790 second-feet); minimum stage recorded, −0.10 foot August 7 (discharge, 0.5 second-foot, estimated).

1915–1917: Maximum stage about 5.0 feet February 8, 1916 (discharge approximately 900 second-feet); minimum stage recorded, 0.55 foot August 6 to September 18, 1915 (discharge, 0.2 second-foot).

ICE.—Stage-discharge relation affected by ice.

DIVERSIONS.—Several canals divert water for irrigation above station, mostly in the vicinity of Ashwood.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during flood of March 27. Rating curve used previous to that date fairly well defined; curve used March 27 to September 30 poorly defined. Gage read to half-tenths twice daily. Daily discharge ascertained by applying daily gage height to rating table. Records fair.

Discharge measurements of Trout Creek near Antelope, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
May 26	C. L. Batchelder	1.90	92
Aug. 7	R. C. Briggs	−.10	[a] 0.5

[a] Estimated.

Digitized by Google

Daily discharge, in second-feet, of Trout Creek near Antelope, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	.....	2.0	2.0	2.0	3.0	4.0	64	130	69	12
2	.....	2.0	2.0	3.0	3.0	4.0	56	130	69	10
3	.....	2.0	2.0	5.0	3.0	5.6	74	114	69	9.2
4	.....	2.0	2.0	4.0	3.0	6.6	41	114	69	8.8
5	.....	2.0	2.0	3.6	3.0	9.6	99	114	69	8.8
6	.....	2.0	2.0	5.0	3.0	11	86	114	60	8.0
7	.....	2.0	2.0	5.0	31	15	181	130	60	8.0
8	.....	2.0	2.0	7.5	25	15	210	146	60	6.0
9	.....	2.0	2.0	6.0	20	15	122	130	51	4.0
10	.....	1.5	2.0	3.0	20	15	114	154	51	2.0
11	.....	1.5	2.0	3.0	16	15	138	230	44	1.8
12	.....	1.5	2.0	1.5	16	12	130	190	44	1.6
13	.....	1.5	2.0	1.5	16	12	99	172	38	1.4
14	.....	1.5	2.0	1.5	16	11	130	172	32	1.0
15	.....	1.5	2.0	.8	16	11	86	154	32	.....
16	.....	1.5	2.0	1.5	25	13	64	154	27	.....
17	.....	1.0	2.0	3.0	25	15	86	154	23	.....
18	.....	1.0	2.0	3.0	18	15	74	172	23	.....
19	.....	1.0	2.0	3.0	17	16	122	172	21	.....
20	.....	1.0	2.0	5.0	12	17	130	172	19	.....
21	1.0	1.5	2.0	.....	12	19	138	172	19	.....
22	1.0	1.5	2.0	.....	6.0	21	190	154	18	.....
23	1.0	2.0	2.0	.....	6.0	25	370	122	17	.....
24	1.0	2.0	2.0	.....	6.0	25	250	92	17	.....
25	1.0	2.0	2.0	.....	5.6	60	290	92	17	.....
26	1.0	2.0	2.0	.....	6.6	31	250	92	17	.....
27	1.5	1.5	2.0	.....	4.0	390	290	80	16	.....
28	2.0	1.5	2.0	.....	3.6	92	270	80	16	.....
29	2.0	2.0	2.0	.....	.....	138	240	80	14	.....
30	2.0	2.0	2.0	.....	.....	69	146	80	13	.....
31	2.0	.....	2.0	.....	.....	60	.....	80	.....	.....

NOTE.—Mean discharge estimated Jan. 21 to Feb. 3, 3 second-feet.

Monthly discharge of Trout Creek near Antelope, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October 21-31	2.0	1.0	1.41	31
November	2.0	1.0	1.68	100
December	2.0	2.0	2.00	123
January	7.5	.8	3.25	200
February	31	3.0	12.2	678
March	390	4.0	37.7	2,320
April	370	41	151	8,980
May	230	80	134	8,240
June	69	13	36.5	2,170
July 1-14	12	1.0	5.90	164
The period	.....	.....	.....	23,000

WARM SPRINGS RIVER NEAR WARM SPRING, OREG.

LOCATION.—In NE. ¼ sec. 19, T. 8 S., R. 13 E., in Wasco County, at bridge on road between Warm Spring and Simnasho, 9 miles from Warm Spring.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 29, 1911, to September 30, 1917 (fragmentary prior to 1914).

GAGE.—Stevens water-stage recorder since July 1, 1914; fastened to downstream side of right abutment. Observers, Jerry Brunoe and Willie Palmer. Vertical staff spiked to upstream side of right abutment of old bridge, July 29, 1911, to July 1, 1914.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge or by wading.

CHANNEL AND CONTROL.—Control is of gravel and small boulders about 100 yards below bridge; practically permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.56 feet at noon May 12 (discharge, 1,540 second-feet); minimum stage recorded, 0.90 foot January 27 (discharge, 262 second-feet).

1911–1917: Maximum stage recorded, 4.0 feet at 10 p. m., March 9, 1916 (discharge, 2,930 second-feet); minimum stage recorded, 0.73 foot January 15, 1915 (discharge, 192 second-feet).

ICE.—River probably never freezes, as there are hot springs just above bridge.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Water-stage recorder operated satisfactorily April 12 to July 28 only. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting the recorder graph. Records good for October and for period April to July; fair for remainder of year.

Discharge measurements of Warm Springs River near Warm Spring, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Apr. 13	C. L. Batchelder	1.80	782
May 28	do	2.06	982
Aug. 9	R. C. Briggs	1.03	309

Daily discharge, in second-feet, of Warm Springs River near Warm Spring, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	305	328						882	1,090	564		
2	305	314	350					834	1,050	540		
3	305	318						826	957	534		
4	305	328			332			802	882	534		
5	305	332			350			794	842	528		
6	305	323		350	370		700	778	834	522		
7	305	328			355			966	874	504		
8	305	318			346			1,030	930	486		
9	305	318			338			1,120	1,000	462	314	
10	305	323			346			1,240	1,020	445	314	
11	305	328			350			1,340	939	430	310	
12	305				355			1,430	850	415	305	
13	305				390		770	1,380	763	415	305	
14	305				390		749	1,340	756	415	310	
15	305				390		707	1,240	756	415	314	
16	305			284	425		658	1,170	794	400	310	
17	305				435		618	1,090	834	405	305	
18	305		305		415		588	1,030	834	400	305	
19	305	314			405		558	984	818	405		
20	305	314			400		552	922	818	390		
21	305	314			390		582	898	810	390		
22	305	314			385		588	882	810	385		
23	305	314			370	400	637	874	763	390		
24	305	314			350		763	866	721	375		
25	305	314			328		858	842	686	365		
26	305						1,000	826	658	360		305
27	305			262			1,100	874	624	355		
28	305						1,090	975	606	350		
29	305						1,020	1,090	600			
30	328					630	957	1,160	582			
31	328							1,130				

NOTE.—Mean discharge estimated as follows: Nov. 12–18 and 26–30, 320 second-feet; Feb. 1–3, 300 second-feet; Feb. 26–28, 310 second-feet; Apr. 1–5, 660 second-feet; Apr. 7–12, 770 second-feet; July 29–31, 340 second-feet; Aug. 1–8, 320 second-feet; Aug. 19–31, 300 second-feet. Discharge interpolated Nov. 20–23.

99664°—20—WSP 464——5

Digitized by Google

Monthly discharge of Warm Springs River near Warm Spring, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	328	305	306	18,800
November	.....	314	320	19,000
December	.....	.....	a 320	19,700
January	.....	.....	a 300	18,400
February	435	.....	359	19,900
March	.....	.....	a 370	22,800
April	1,100	552	747	44,400
May	1,430	778	1,020	62,700
June	1,090	582	817	48,600
July	564	.....	426	26,200
August	.....	.....	308	18,900
September	.....	.....	a 300	17,900
The year	1,430	.....	466	337,000

a Estimated.

WHITE RIVER NEAR TYGH VALLEY, OREG.

LOCATION.—In SW. ¼ sec. 10, T. 4 S., R. 13 E., 1 mile south of Tygh Valley, Wasco County, 1 mile above mouth of Tygh Creek, and 4 miles above Tygh Valley plant of Pacific Power & Light Co. at fall of White River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 18, 1911, to September 30, 1917.

GAGE.—Vertical staff on lower corner of left pier of highway bridge. Gage reader, Mrs. Bessie Nickerson.

DISCHARGE MEASUREMENTS.—Made from lower side of highway bridge.

CHANNEL AND CONTROL.—Gravel and sand; slightly shifting. White River carries a heavy load of glacial sediment at times.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.95 feet June 9 (discharge 1,530 second-feet); minimum stage recorded, 0.50 foot December 29 to 31 (discharge, 131 second-feet).

1911–1917: Maximum stage recorded, 5.3 feet January 9, 1912 (probably ice affected); maximum open-water stage 3.5 feet January 13, 1912 (discharge, 2,050 second-feet). Minimum stage recorded 0.25 foot October 18 and 19, 1915 (discharge, 75 second-feet).

ICE.—Stage-discharge relation affected by ice for short periods; ice jams occasionally form during extremely cold weather.

DIVERSIONS.—The Wapinitia Irrigation Co. began diverting a small quantity of water in the spring of 1917 from Clear Creek, a tributary of White River. This water will be used to irrigate land lying south of White River known as Juniper Flats.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during high water of May 11–13. Rating curve used October 1 to May 13 well defined between 100 and 1,200 second-feet; curve used May 14 to September 30 well defined between 100 and 300 second-feet and fairly well defined above 300 second-feet. Gage read to quarter-tenths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records good.

Digitized by Google

Discharge measurements of White River near Tygh Valley, Oreg., during the year 1917.

[Made by C. L. Batchelder.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Apr. 14	1.31	452	Aug. 23	0.79	[b] 176
May 21	2.30	[a] 876	Oct. 18	.60	115
23	2.25	975			

[a] Measuring section poor on account of eddies; next measurement considered better.
[b] Measurement made by wading; conditions good.

Daily discharge, in second-feet, of White River near Tygh Valley, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	164	173	188	158	158	188	380	680	1,300	740	255	162
2	161	158	182	173	144	188	358	680	1,230	740	255	162
3	158	188	182	182	238	220	335	680	1,160	740	235	162
4	158	204	204	182	255	194	295	680	1,090	810	235	162
5	158	188	204	238	238	255	380	710	1,090	810	215	156
6	158	188	188	238	220	214	405	780	1,090	810	215	156
7	158	188	173	220	220	220	430	920	1,230	710	215	156
8	158	173	158	204	220	220	535	1,060	1,370	680	215	156
9	158	188	188	204	220	220	508	1,280	1,530	650	215	156
10	153	295	158	188	220	220	480	1,440	1,300	620	208	162
11	153	214	158	188	220	204	480	1,520	1,160	620	208	156
12	153	188	173	188	238	204	480	1,520	1,020	620	208	145
13	153	204	220	173	238	220	480	1,520	950	560	198	145
14	153	204	188	173	220	188	480	1,370	1,020	532	198	145
15	153	188	173	158	220	188	455	1,370	1,230	505	198	180
16	158	164	158	220	295	194	430	1,160	1,370	505	198	162
17	158	153	173	204	335	188	380	1,090	1,370	505	198	156
18	158	158	173	158	335	194	380	1,020	1,230	505	187	145
19	153	158	188	158	295	204	380	1,020	1,230	450	187	145
20	153	158	158	158	255	220	380	950	1,230	422	180	145
21	158	153	188	144	255	220	430	950	1,160	395	180	145
22	158	153	188	158	238	188	430	1,020	1,090	345	180	145
23	153	158	188	158	238	214	480	950	950	345	180	145
24	153	158	173	158	238	335	535	1,020	950	322	180	152
25	153	158	173	188	220	255	710	950	950	300	180	145
26	158	220	173	188	220	255	990	950	880	300	173	156
27	158	255	158	188	220	295	920	1,020	810	300	173	145
28	158	220	144	188	204	380	920	1,160	880	291	162	139
29	153	214	131	173	.....	430	920	1,370	880	255	162	145
30	173	220	131	188	.....	380	780	1,370	740	255	162	139
31	191	.....	131	158	.....	335	.....	1,370	.....	255	162	.....

Monthly discharge of White River near Tygh Valley, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	191	153	158	9,720
November	295	153	188	11,200
December	220	131	173	10,600
January	238	144	182	11,200
February	335	144	236	13,100
March	430	188	240	14,800
April	990	295	518	30,800
May	1,520	680	1,080	66,400
June	1,530	740	1,120	66,600
July	810	255	513	31,500
August	255	162	197	12,100
September	180	139	152	9,040
The year	1,530	131	397	287,000

Digitized by Google

KLICKITAT RIVER BASIN.

KLICKITAT RIVER NEAR GLENWOOD, WASH.

LOCATION.—In NE. ¼ sec. 14, T. 7 N., R. 12 E., just below Dairy Creek, 2½ miles below southern boundary of Yakima Indian Reservation, 3 miles below Big Muddy Creek, and about 6 miles north of Glenwood, Klickitat County.

DRAINAGE AREA.—356 square miles.

RECORDS AVAILABLE.—December 16, 1910, to September 30, 1917, at present site; October 9, 1909, to December 15, 1910, at a point a mile above, in section 11.

GAGE.—Stevens continuous water-stage recorder referred to vertical staff on left bank. Observer, A. G. Hanson. Prior to July 19, 1910, several vertical staffs were used.

DISCHARGE MEASUREMENTS.—Made from cable just below gage.

CHANNEL AND CONTROL.—Heavy gravel; shifting.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 2.90 feet at 7 a. m. June 9 (discharge, 3,300 second-feet); minimum stage, from water-stage recorder, 0.19 foot at 12 p. m. January 15 (discharge, 325 second-feet).

1909–1917: Maximum stage recorded, 5.20 feet on original gage November 24, 1909 (discharge, estimated by extension of rating curve, 6,250 second-feet); minimum discharge recorded, 285 second-feet November 13, 1915.

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; changed slightly in November and again (above 850 second-feet) during May. Three well-defined rating curves used, one applicable October 1 to November 26, one December 10 to May 16, and one May 26 to September 30 (except July 30 to Aug. 18). Operation of water-stage recorder fairly satisfactory; paper did not run straight and considerable correction was necessary for period May to July. Daily discharge ascertained by applying to rating table the mean daily gage height ascertained by inspecting recorder graph; shifting-control method used May 17–25 and July 30 to August 18. Records good.

Discharge measurements of Klickitat River near Glenwood, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 18	A. G. Hanson	0.57	567	May 30	A. G. Hanson	2.63	2,860
Nov. 3	do	.62	579	June 22	do	2.27	2,300
Feb. 8	do	.38	419	30	do	1.94	1,890
Mar. 12	do	.30	384	July 27	do	1.16	968
Apr. 2	W. E. Dickinson	.35	415	Aug. 18	do	.83	822
9	do	.57	531	Sept. 13	do	.56	539
May 13	A. G. Hanson	2.02	2,150				

Digitized by Google

Daily discharge, in second-feet, of Klickitat River near Glenwood, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	628	570	.....	500	416	380	410	.....	2,820	1,850	913	.....
2	628	586	.....	488	416	355	404	.....	2,520	1,910	940	.....
3	622	604	.....	476	416	.....	398	.....	2,300	2,020	931	.....
4	616	676	.....	470	422	.....	404	.....	2,160	2,090	895	.....
5	610	622	.....	458	428	.....	416	.....	2,160	2,090	868	.....
6	604	622	.....	458	428	.....	440	.....	2,300	1,950	859	.....
7	598	604	.....	446	428	365	494	.....	2,670	1,810	826	.....
8	592	598	.....	452	428	365	542	.....	2,980	1,720	818	.....
9	592	664	.....	440	440	375	542	.....	3,140	1,770	826	.....
10	592	664	446	434	446	380	542	.....	2,820	1,770	810	.....
11	586	622	446	428	440	386	578	.....	2,440	1,680	818	.....
12	580	586	464	404	446	380	572	.....	2,230	1,620	834	.....
13	580	565	488	375	446	380	566	2,180	2,230	1,570	834	536
14	580	565	488	355	440	370	560	2,240	2,370	1,510	826	560
15	575	565	476	330	440	375	548	2,200	2,740	1,520	826	572
16	570	565	464	.....	452	365	530	2,000	3,140	1,550	818	590
17	570	565	476	.....	464	370	512	1,820	2,980	1,550	818	596
18	565	565	482	.....	464	370	506	1,690	2,900	1,470	818	590
19	555	565	488	.....	464	375	500	1,690	2,820	1,420	.....	590
20	555	560	482	345	458	370	518	1,730	2,670	1,310	.....	560
21	550	555	488	355	458	375	530	1,790	2,520	1,190	.....	530
22	545	555	488	360	452	375	530	1,820	2,370	1,120	.....	536
23	540	545	494	370	452	370	536	1,890	2,160	1,050	.....	530
24	545	545	476	380	446	375	596	1,950	2,230	994	.....	506
25	540	540	446	392	440	380	722	1,880	2,160	976	.....	494
26	540	540	404	392	428	370	794	1,910	2,090	1,000	.....	512
27	545	.....	410	404	392	370	834	2,230	2,160	1,010	.....	524
28	545	.....	422	416	386	380	.....	2,670	2,090	976	.....	536
29	550	.....	458	428	.....	506	.....	2,900	1,950	922	.....	518
30	565	.....	524	428	.....	446	.....	2,900	1,880	922	.....	512
31	592	.....	512	422	.....	410	.....	2,740	.....	904	.....	.....

NOTE.—No gage-height record. Discharge estimated: Nov. 27–30, 550 sec.-ft.; Dec. 1–5, 500 sec.-ft., Dec. 6–9, 450 sec.-ft.; Jan. 16–19, 330 sec.-ft.; Mar. 3–6, 340 sec.-ft.; Apr. 28 to May 5, 850 sec.-ft.; May 6–12, 1,500 sec.-ft.; Aug. 19–31, 750 sec.-ft.; Sept. 1–12, 630 sec.-ft.

Monthly discharge of Klickitat River near Glenwood, Wash., for the year ending Sept. 30, 1917.

[Drainage area, 356 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	628	540	576	1.62	1.87	35,400
November	676	540	580	1.63	1.82	34,500
December	524	404	472	1.33	1.53	29,000
January	500	330	404	1.13	1.30	24,800
February	464	386	437	1.23	1.28	24,300
March	506	.....	377	1.06	1.22	23,200
April	.....	398	569	1.60	1.78	33,900
May	2,900	.....	1,770	4.97	5.73	109,000
June	3,140	1,880	2,470	6.94	7.74	147,000
July	2,090	904	1,460	4.10	4.73	89,800
August	940	.....	807	2.27	2.62	49,600
September	.....	494	578	1.62	1.81	34,400
The year	3,140	330	877	2.46	33.43	635,000

Digitized by Google

BIG MUDDY CREEK NEAR GLENWOOD, WASH.

LOCATION.—In NE. ¼ sec. 3, T. 7 N., R. 12 E., a few hundred feet above mouth of Cougar Creek and about 9 miles north of Glenwood, Klickitat County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 12, 1916, to September 30, 1917; almost directly comparable with record obtained about 3 miles above mouth August 28 to November 12, 1916.

GAGE.—Stevens continuous water-stage recorder on right bank, inspected by A. G. Hanson.

DISCHARGE MEASUREMENTS.—Made from foot log just above gage.

CHANNEL AND CONTROL.—Heavy boulders; shifting. Velocities very high; bottom rough.

EXTREMES OF DISCHARGE.—Maximum stage from water-stage recorder, 3.05 feet July 19, 7 to 9 p. m. (discharge, 362 second-feet); minimum discharge recorded 35 second-feet at 12 p. m. April 3 (gage height 1.21 feet).

1916–1917: Maximum discharge from recorder, 390 second-feet at 6 p. m. September 1, 1916 (gage height 2.13 feet at former station); minimum discharge recorded, 35 second-feet on April 3, 1917.

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Fairly well-defined rating curves applicable November 24 to March 16, April 7 to June 15, and July 18 to September 18; shifting-control method November 12 to 23, April 1 to 6, June 16 to July 17, and September 19 to 30. Operation of water-stage recorder satisfactory November 12 to 29 and April 1 to September 30; during the winter it ran only a few days at a time. Daily discharge ascertained by applying to rating table the mean gage height obtained by inspecting recorder graph. Records good for November, April to June, August, and September; poor for July on account of bad shifts in control; fair December to March, on account of steady flow, although gage-height record is fragmentary.

Discharge measurements of Big Muddy Creek near Glenwood, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 17	A. G. Hanson	1.37	96	May 15	A. G. Hanson	1.83	124
26	do	1.32	65	June 6	do	1.98	158
Jan. 7	do	1.26	64	24	do	2.20	224
Feb. 7	do	1.21	47.2	30	do	2.04	213
Mar. 13	do	1.20	46.5	July 22	do	2.65	264
Apr. 1	W. E. Dickinson	1.23	38.8	Aug. 12	do	2.60	246
9	do	1.28	38.9	Sept. 12	do	2.21	161

Digitized by Google

Daily discharge, in second-feet, of Big Muddy Creek near Glenwood, Wash., for the year ending Sept. 30, 1917.

Day.	Nov.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	.....	.....	.....	39	59	172	220	250	225
2	.....	.....	.....	.....	39	63	150	220	262	225
3	.....	.....	.....	.....	37	61	139	256	250	225
4	.....	.....	.....	.....	39	64	137	280	250	225
5	.....	.....	.....	.....	39	66	150	280	238	225
6	.....	.....	.....	.....	38	77	161	268	250	225
7	.....	57	48	.....	45	86	172	256	250	212
8	.....	57	.....	.....	41	104	184	256	250	200
9	.....	59	.....	.....	38	115	196	256	250	189
10	.....	57	.....	.....	40	129	172	268	225	189
11	.....	.....	.....	.....	44	137	150	256	250	178
12	85	.....	.....	.....	41	131	139	256	250	158
13	111	.....	.....	46	40	133	139	244	250	170
14	105	.....	.....	48	40	139	161	256	238	180
15	• 96	.....	.....	48	39	129	196	280	250	190
16	94	.....	.....	48	38	113	232	306	250	200
17	98	.....	.....	.....	37	111	256	306	250	212
18	94	.....	.....	.....	37	106	268	288	262	200
19	87	.....	.....	.....	38	106	268	300	262	212
20	83	.....	.....	.....	41	108	244	275	262	212
21	83	.....	.....	.....	40	115	232	275	250	212
22	77	.....	.....	.....	40	117	208	262	238	200
23	75	.....	.....	.....	43	127	196	250	238	189
24	71	.....	.....	.....	48	131	232	238	238	178
25	77	.....	.....	.....	64	135	208	238	238	168
26	69	.....	.....	.....	63	161	208	250	225	168
27	87	.....	.....	.....	61	161	220	250	225	158
28	77	.....	.....	.....	61	172	232	250	225	168
29	73	.....	.....	.....	63	184	220	225	225	168
30	70	.....	.....	.....	60	172	220	225	238	168
1	.....	.....	.....	.....	.....	172	.....	238	225	.....

Monthly discharge of Big Muddy Creek near Glenwood, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	150	103	121	7,440
November	120	69	92.4	5,500
December	.....	.....	[a] 65	4,000
January	.....	.....	[a] 55	3,380
February	.....	.....	[a] 50	2,780
March	.....	.....	[a] 45	2,770
April	64	37	44.4	2,640
May	184	59	119	7,320
June	268	137	195	11,600
July	306	220	259	15,900
August	262	225	244	15,000
September	225	158	194	11,500
The year	306	37	124	89,800

[a] Estimated.

NOTE.—Record for Oct. 1 to Nov. 11 from station temporarily maintained 3 miles upstream.

Digitized by Google

HOOD RIVER BASIN.

HOOD RIVER AT DEE, OREG.

LOCATION.—In SW. ¼ sec. 7, T. 1 N., R. 10 E., just above backwater of mill dam at Dee, Hood River County, and half a mile below junction of East and Middle forks.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 21, 1913, to December 31, 1914; February 1, 1915, to January 15, 1916; May 9 to December 15, 1917, when station was discontinued.

GAGE.—Stevens 8-day water-stage recorder at wooden crib on left bank just above railroad trestle; installed May 18, 1917; inspected by C. E. Stricklin and James Shepler. Vertical staff at same site, February 1, 1915, to May 17, 1917. Gage 400 feet below dam was used 1913 to December 31, 1914.

DISCHARGE MEASUREMENTS.—Made from cable about 25 feet above gage.

CHANNEL AND CONTROL.—Control of boulders, stumps, and gravel; somewhat shifting.

EXTREMES OF DISCHARGE.—Maximum stage during period May 9 to December 15, about 4 feet during night of November 29–30 (observed from high-water mark the next morning); discharge, estimated from extension of rating curve 2,400 second-feet. Minimum stage recorded, 0.04 foot at 7 p. m. November 23; discharge, 207 second-feet.

1913–1917: Maximum discharge recorded is that of 1917, but was considerably exceeded in December, 1917 (no record); minimum discharge, 134 second-feet, September 7, 10, and 11, 1915 (gage height, 0.58 foot). The minimum of 60 second-feet at the station below dam in 1914 was caused by holding backwater at dam and is not the minimum natural flow.

ICE.—Stage discharge relation unaffected by ice.

DIVERSIONS.—Several small ditches divert water for irrigation above station. The East Fork Irrigation District canal diverts water through a divide to lands outside the drainage area.

REGULATION.—None. The flow at former station is quite irregular, especially during low water, owing to changes in load in power plant at mill of Oregon Lumber Co., just above gage.

ACCURACY.—Stage-discharge relation changed by filling May 28. Rating curve used after May 28 fairly well defined; this curve applicable May 9 to 28 adding 0.1 foot to gage heights. Operations of water-stage recorder satisfactory except from 10 p. m. November 29 to 3 p. m. December 2, when it was removed on account of flood. Daily discharge ascertained by applying to the rating table mean daily gage heights determined by inspecting gage-height graph. Results good.

Discharge measurements of Hood River at Dee, Oreg., during the period, Oct. 1, 1916, to Dec. 15, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1916.		*Feet.*	*Sec.-ft.*	1917.		*Feet.*	*Sec.-ft.*
Oct. 26	Rhea Luper [a]	0.22	261	July 7	C. E. Stricklin	1.42	770
				21	do	1.22	712
1917.				24	do	.90	589
May 9	C. E. Stricklin [a]	1.65	940	Aug. 3	do	.72	459
17	C. L. Batchelder	1.40	828	10	do	.46	326
June 1	C. E. Stricklin	1.76	956	13	do	.50	358
8	do	1.68	924	30	do	.24	279
15	do	1.64	871	Nov. 24	R. C. Briggs	.05	213
19	do	1.71	935				

[a] Assistant to State engineer.

Digitized by Google

Daily discharge, in second-feet, of Hood River at Dee, Oreg., for the period May 9 to Dec. 15, 1917.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	980	780	450	278	330	260	780
2	.....	880	830	450	278	330	260	370
3	.....	830	880	472	278	330	350	350
4	.....	780	930	472	278	330	260	370
5	.....	780	930	430	278	330	225	350
6	.....	780	880	430	278	330	260	350
7	.....	880	830	410	260	312	295	312
8	.....	980	780	370	295	312	260	312
9	980	1,080	830	370	330	330	225	295
10	980	930	830	370	330	330	210	295
11	1,180	830	830	370	350	312	225	278
12	1,080	780	830	390	350	312	278	410
13	1,080	780	780	390	330	295	210	1,030
14	1,030	830	730	390	370	295	210	1,230
15	1,030	930	780	370	410	295	210	830
16	950	1,030	830	410	410	295	210	.....
17	860	1,080	880	430	430	278	210	.....
18	780	980	880	390	410	278	210	.....
19	780	980	880	370	410	278	210	.....
20	780	980	780	370	410	260	210	.....
21	780	980	730	370	370	278	210	.....
22	780	930	680	330	350	278	210	.....
23	780	830	585	330	350	278	210	.....
24	780	880	540	350	312	278	210	.....
25	780	830	518	350	350	278	210	.....
26	780	830	562	312	370	278	210	.....
27	880	780	585	295	370	278	225	.....
28	980	830	540	295	390	260	295	.....
29	980	830	472	278	370	260	600	.....
30	980	780	450	295	350	260	1,350	.....
31	980	.....	472	278	.....	260	.....	.....

NOTE.—Daily discharge interpolated May 16 and 17; obtained by applying table to gage heights of 6-hour periods Nov. 29 and from one daily reading and high-water mark Nov. 30.

Monthly discharge of Hood River at Dee, Oreg., for period May 9 to Dec. 15, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
May 9-31	1,180	780	913	41,700
June	1,080	780	887	52,800
July	930	450	737	45,300
August	472	278	374	23,000
September	430	260	345	20,500
October	330	260	295	18,100
November	1,350	210	274	16,300
December 1-15	1,230	278	504	15,000
The period	.....	.....	.....	233,000

Digitized by Google

HOOD RIVER AT TUCKER BRIDGE, NEAR HOOD RIVER, OREG.

LOCATION.—In SE. ¼ sec. 15, T. 2 N., R. 10 E., at Tucker Bridge, 5 miles south of Hood River, Hood River County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 20, 1897, to December 31, 1899; August 27, 1913, to September 30, 1914; July 24, 1915, to September 3, 1917, when station was discontinued.

GAGE.—Chain gage attached to highway bridge; read by F. J. Knoblock. Wire gage attached to an earlier bridge, used 1897 to 1899; Stevens water-stage recorder on right bank one-third mile above intake of power flume and three-fourths mile above bridge, July 24 to December 21, 1915, when it was washed out by a flood.

DISCHARGE MEASUREMENTS.—Made from highway bridge; flow of flume included in that of river. Measuring conditions only fair.

CHANNEL AND CONTROL.—Rocks and boulders; practically permanent at both locations.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.56 feet at 8 a. m. June 8 (discharge, 3,870 second-feet). Minimum stage recorded, 1.35 feet at 8 a. m. October 10 and 6.30 p. m. September 3 (discharge, 428 second-feet).

1897–1899 and 1913–1916: Maximum stage recorded, 6.8 feet (determined by leveling to high-water marks) at water-stage recorder about 1 a. m. December 22, 1915 (discharge approximately 14,600 second-feet). Minimum stage recorded, 0.62 foot at 1 a. m. September 16, 1915 (discharge, 136 second-feet). This minimum was caused by holding water back at dam at Dee and is not representative of natural low-water flow.

ICE.—Stage-discharge relation unaffected.

DIVERSIONS.—Several large diversions for irrigation above station. Power flume diverts water a few hundred feet above the bridge and discharges directly below it; diversion included in records.

REGULATION.—Water stored at sawmill at Dee. During low water of 1914 and 1915 the pond was filled and emptied as many as six times daily, causing fluctuations of as much as 0.8 foot at Tucker Bridge. During 1916 and 1917 steam was used to supplement water power at Dee and the stage fluctuated through only a small range.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve poorly defined for current year. Chain gage read to quarter-tenths twice daily when observer was at home. Daily discharge ascertained by applying mean daily gage height to rating table. Records fair.

Discharge measurements of Hood River at Tucker Bridge, near Hood River, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 10	C. L. Batchelder	2.35	898	May 31	C. E. Stricklin [a]	3.80	2,150
May 8	C. E. Stricklin [a]	4.20	1,860	July 25	do	2.35	807
12	do	4.60	2,400				

[a] Assistant to State engineer

Digitized by Google

Daily discharge, in second-feet, of Hood River at Tucker Bridge, near Hood River, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	445	600	1,070	a 640	750	650	1,190	1,680	1,900	1,520	750	445
2	445	700	950	700	800	650	1,250	1,520	1,800	1,680	750	.....
3	445	750	1,070	900	1,130	600	1,190	1,600	1,700	1,760	750	428
4	445	1,130	1,190	1,100	1,130	700	1,250	1,520	1,600	1,840	700	.....
5	428	700	1,190	2,480	1,130	950	1,840	1,380	1,600	1,680	700	.....
6	445	750	950	1,900	1,190	850	1,600	1,600	1,760	1,680	700	.....
7	445	750	900	1,400	1,070	800	2,380	2,200	2,020	1,520	650	.....
8	445	750	850	1,190	1,070	800	2,300	2,200	2,290	a 1,560	600	.....
9	428	1,010	a 800	1,130	1,010	a 785	1,930	2,580	2,790	1,600	580	.....
10	428	900	750	1,070	a 1,070	a 770	1,600	2,480	2,100	1,520	600	.....
11	445	800	700	1,010	1,130	a 750	1,760	2,580	1,950	1,450	580	.....
12	428	650	a 800	950	1,070	a 730	1,680	2,580	1,600	1,450	600	.....
13	445	600	900	a 900	950	a 715	1,450	2,480	1,600	1,310	600	.....
14	480	580	800	a 850	950	700	a 1,380	2,200	1,800	1,310	580	.....
15	480	600	800	800	950	700	1,310	2,110	2,200	1,380	560	.....
16	480	580	800	750	1,130	650	1,250	1,930	2,490	1,450	580	.....
17	500	580	700	750	a 1,040	650	1,190	1,680	2,290	1,520	600	.....
18	500	580	750	700	950	650	1,130	1,520	2,200	1,450	580	.....
19	480	540	800	700	900	700	1,130	1,680	2,200	1,450	580	.....
20	462	520	900	a 700	900	750	1,190	a 1,640	2,020	1,380	560	.....
21	462	540	950	a 700	850	750	1,190	1,600	2,200	1,190	580	.....
22	445	520	900	700	850	750	1,190	1,600	2,020	1,070	560	.....
23	445	520	900	a 675	750	850	1,600	1,520	1,700	1,010	560	.....
24	445	540	850	650	a 725	1,250	1,600	1,520	1,950	950	560	.....
25	445	1,010	b 800	650	700	1,010	2,110	1,520	1,950	900	520	.....
26	445	1,070	750	650	700	900	2,290	1,520	1,800	900	a 491	.....
27	500	2,110	700	1,520	700	1,010	2,100	1,600	1,680	900	462	.....
28	462	1,520	700	1,010	700	1,310	1,930	1,760	1,800	900	462	.....
29	650	1,160	650	900	.....	1,840	1,760	1,680	1,700	850	462	.....
30	650	1,190	600	900	.....	1,310	1,680	a 1,760	1,600	750	462	.....
31	900	.....	580	800	.....	1,190	.....	1,840	.....	750	445	.....

a Discharge interpolated.

NOTE.—Discharge estimated from flow at Powerdale, Jan. 3, 4, 6, 7; Mar. 4, Apr. 8; May 26, 27; June 1–4, 10–16, 23–26, and 28–30.

Monthly discharge of Hood River at Tucker Bridge, near Hood River, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean	
October	900	428	482	29,600
November	2,110	520	808	48,100
December	1,190	580	840	51,600
January	2,480	640	960	59,000
February	1,190	700	939	52,100
March	1,840	600	862	53,000
April	2,380	1,130	1,580	94,000
May	2,580	1,380	1,840	113,000
June	2,790	1,600	1,940	115,000
July	1,840	750	1,310	80,600
August	750	445	586	36,000
The period	.....	.....	.....	732,000

Digitized by Google

HOOD RIVER AT POWERDALE, NEAR HOOD RIVER, OREG.

LOCATION.—In NE. ¼ sec. 36, T. 3 N., R. 10 E., at Powerdale, about three-quarters of a mile south of town of Hood River, Hood River County, above discharge of tailrace of Powerdale plant of Pacific Power & Light Co., and 1½ miles above mouth of stream.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 31, 1913 to September 30, 1917.

GAGE.—Vertical staff on right bank opposite power plant, about one-half mile above railroad bridge, in the SE. ¼ sec. 36; used March 31, 1913, to September 30, 1914, and after December 21, 1915. Vertical staff on left bank just below bridge of Mount Hood Railway, October 1, 1914, to July 26, 1915. Water-stage recorder at same site July 27 to December 21, 1915. Gage reader, A. Rogers.

DISCHARGE MEASUREMENTS.—Made from cable 100 feet above gage at power plant.

CHANNEL AND CONTROL.—Rock and boulders; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.0 feet at noon November 27 (discharge, 4,500 second-feet); minimum stage recorded, 1.50 feet at 3 p. m. October 4 (discharge, 290 second-feet).

1913–1917: Maximum stage recorded, 7.5 feet, on gage opposite power plant, at 1 a. m. December 22, 1915 (discharge approximately 12,200 second-feet); minimum stage recorded, 1.33 feet September 4, 1915 (discharge, estimated from extension of rating curve, 176 second-feet).

ICE.—Stage-discharge relation not materially affected by ice.

DIVERSIONS.—Large diversions for irrigation above station; water for power plant is diverted around upper gage, but is returned above the bridge gage. A record of this diversion has been kept (p. 83).

REGULATION.—Water stored at sawmill at Dee causes sudden fluctuations at low water, but this has been much less noticeable since 1916 than in 1914 or 1915.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 290 and 5,000 second-feet. Gage read to quarter tenths four times daily. Daily discharge ascertained by applying mean daily gage height to rating table. Record October to July, excellent; August, good; September, fair.

Discharge measurements of Hood River at Powerdale, near Hood River, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 9	C. L. Batchelder	2.65	1,080	July 23	C. E. Stricklin [a]	2.45	1,020
June 12	C. E. Stricklin [a]	3.21	1,520	Aug. 8	do	2.15	670
20	do	3.60	2,080				

[a] Assistant to State engineer.

Digitized by Google

Daily discharge, in second-feet, of Hood River at Powerdale, near Hood River, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	600	565	1,060	600	705	670	1,240	1,710	2,070	1,610	860	558
2	467	635	980	780	705	670	1,510	1,610	1,940	1,710	900	544
3	436	635	1,420	900	1,060	635	1,330	1,610	1,820	1,710	940	530
4	400	1,020	1,240	1,150	1,240	705	1,240	1,510	1,610	1,710	900	502
5	418	740	1,240	2,340	1,240	1,060	1,820	1,510	1,610	1,820	820	558
6	412	705	1,060	1,940	1,330	900	1,710	1,610	1,820	1,610	820	551
7	406	705	860	1,420	1,150	900	2,340	2,200	1,940	1,510	780	600
8	412	705	820	1,240	1,060	820	2,340	2,200	2,200	1,610	705	600
9	400	980	780	1,150	1,060	820	2,070	2,490	2,490	1,610	780	740
10	400	940	780	1,060	1,060	780	1,820	2,490	2,070	1,420	740	705
11	400	780	705	980	1,060	780	1,940	2,490	1,940	1,420	740	705
12	400	586	780	900	1,150	780	1,820	2,490	1,610	1,420	740	740
13	412	530	900	980	1,060	740	1,710	2,340	1,610	1,420	780	705
14	412	530	860	940	1,060	820	1,610	2,200	1,820	1,330	780	670
15	412	516	860	780	980	780	1,510	2,070	2,200	1,420	820	820
16	430	516	820	670	1,150	740	1,420	1,820	2,490	1,420	780	820
17	454	502	820	670	980	740	1,330	1,710	2,340	1,420	820	780
18	412	530	820	635	1,060	740	1,240	1,710	2,070	1,420	820	740
19	406	495	900	600	980	740	1,240	1,710	2,200	1,420	740	740
20	436	474	940	635	940	780	1,240	1,610	2,070	1,330	740	740
21	424	460	1,060	670	900	740	1,420	1,610	2,070	1,240	820	670
22	412	474	940	586	860	740	1,420	1,610	1,940	1,060	705	635
23	400	481	900	572	820	860	1,710	1,610	1,710	980	705	670
24	400	488	820	572	940	1,420	1,710	1,610	1,940	900	705	586
25	400	1,060	820	635	900	1,240	2,070	1,610	1,940	820	670	579
26	406	1,060	780	572	860	1,060	2,340	1,610	1,820	860	484	635
27	460	2,970	740	1,330	740	1,240	2,070	1,610	1,710	1,060	516	635
28	412	1,610	670	1,060	705	1,330	1,940	2,070	1,820	980	530	600
29	600	1,240	600	900	.....	1,820	1,820	2,340	1,710	860	544	635
30	586	1,240	516	820	.....	1,820	1,820	2,200	1,610	820	572	600
31	860	.....	635	670	.....	1,330	.....	2,070	.....	820	572	.....

Monthly discharge of Hood River at Powerdale, near Hood River, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	860	400	448	27,500
November	2,970	460	806	48,000
December	1,420	516	875	53,800
January	2,340	572	928	57,100
February	1,330	705	991	55,000
March	1,820	635	942	57,900
April	2,340	1,240	1,690	101,000
May	2,490	1,510	1,900	117,000
June	2,490	1,610	1,940	115,000
July	1,820	820	1,310	80,600
August	940	484	736	45,300
September	820	502	653	38,900
The year	2,970	400	1,100	797,000

Digitized by Google

Combined daily discharge, in second-feet, of Hood River and Pacific Power & Light Co.'s tailrace at Powerdale, near Hood River, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	680	638	1,060	670	802	733	1,280	1,750	2,160	1,620	860	558
2	549	708	980	850	802	750	1,510	1,650	2,030	1,770	900	544
3	518	708	1,420	994	1,160	711	1,420	1,650	1,830	1,780	940	530
4	483	1,090	1,240	1,240	1,280	755	1,320	1,550	1,610	1,720	900	502
5	498	810	1,280	2,430	1,330	1,130	1,900	1,580	1,610	1,890	820	558
6	494	775	1,060	2,040	1,430	955	1,790	1,620	1,830	1,680	820	551
7	486	772	954	1,480	1,250	958	2,420	2,280	1,950	1,580	780	600
8	459	778	914	1,340	1,150	903	2,380	2,260	2,210	1,620	705	600
9	485	1,050	874	1,250	1,150	906	2,150	2,560	2,530	1,610	780	740
10	483	1,010	794	1,150	1,110	870	1,900	2,560	2,150	1,520	740	705
11	483	780	791	1,070	1,100	866	2,020	2,560	2,010	1,490	740	705
12	483	672	866	994	1,170	870	1,900	2,560	1,680	1,490	740	740
13	495	616	986	1,060	1,060	837	1,790	2,350	1,680	1,490	780	705
14	495	616	907	954	1,060	820	1,690	2,200	1,890	1,390	780	670
15	492	602	874	874	1,020	780	1,550	2,130	2,270	1,440	820	820
16	513	602	826	764	1,230	820	1,460	1,880	2,560	1,490	780	820
17	537	588	823	760	1,060	780	1,410	1,720	2,340	1,480	820	798
18	495	616	823	732	1,100	813	1,320	1,720	2,140	1,490	820	758
19	489	575	903	697	1,060	816	1,320	1,720	2,260	1,490	740	740
20	516	550	943	729	1,010	820	1,320	1,620	2,140	1,430	740	740
21	500	536	1,060	710	980	780	1,500	1,620	2,140	1,330	820	720
22	495	550	1,010	680	936	830	1,490	1,620	2,010	1,150	705	667
23	476	554	914	666	872	946	1,780	1,620	1,780	1,070	705	702
24	480	561	896	666	998	1,480	1,780	1,620	2,010	993	705	662
25	476	1,130	834	732	958	1,280	2,140	1,620	2,010	910	670	627
26	489	1,120	794	669	930	1,140	2,410	1,620	1,890	950	484	684
27	543	3,000	754	1,430	816	1,320	2,140	1,710	1,720	1,060	516	686
28	495	1,610	746	1,130	781	1,410	2,020	2,150	1,860	980	530	648
29	683	1,240	676	997	.....	1,900	1,830	2,420	1,780	860	544	687
30	669	1,240	592	884	.....	1,900	1,860	2,280	1,680	820	572	649
31	943	.....	649	767	.....	1,410	.....	2,160	.....	820	572	.....

Combined monthly discharge of Hood River and Pacific Power & Light Co.'s tailrace at Powerdale, near Hood River, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	943	459	528	32,500
November	3,000	536	870	51,800
December	1,420	592	911	56,000
January	2,430	666	1,020	62,700
February	1,430	781	1,060	58,900
March	1,900	710	1,010	62,100
April	2,420	1,280	1,760	105,000
May	2,560	1,550	1,950	120,000
June	2,560	1,610	1,990	118,000
July	1,890	820	1,370	84,200
August	940	484	736	45,300
September	820	502	671	39,900
The year	3,000	459	1,150	836,000

EAST FORK OF HOOD RIVER NEAR MOUNT HOOD, OREG.

LOCATION.—In SW. ¼ sec. 4, T. 1 S., R. 10 E., 1,000 feet above intake of East Fork Irrigation District canal, three-quarters of a mile above toll bridge and former gage, and 2 miles south of Mount Hood post office, Hood River County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 22, 1915, to September 30, 1917.

GAGE.—Stevens eight-day water-stage recorder on left bank. Observer, C. H. Shaw.

DISCHARGE MEASUREMENTS.—Made from cable at gage, or by wading.

CHANNEL AND CONTROL.—Heavy boulders; practically permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 3.20 feet at 1 a. m. June 9 (discharge, 700 second-feet); minimum stage recorded, 1.23 feet at 10 a. m. March 15 (discharge, 126 second-feet).

1915–1917: Maximum stage from water-stage recorder, 4.33 feet at 11 p. m. December 21, 1915 (discharge, 1,280 second-feet); minimum stage recorded, 1.20 feet November 11, 1915 (discharge, 108 second-feet).

ICE.—Stage-discharge relation unaffected by ice, but float is sometimes frozen in.

DIVERSIONS.—The Glacier ditch and other small ditches divert water for irrigation above the station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during year. Transition rating curve used October 1 to 25; fairly well defined. Curve used October 26 to September 30 well defined between 122 and 600 second-feet. Operation of water-stage recorder satisfactory, except June 17 to 22 and 24–29, for which periods discharge has been interpolated. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting gage-height graph. Records excellent.

Discharge measurements of East Fork of Hood River near Mount Hood, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 25	Luper [a] and Donnelly [a]	1.44	158	July 28	C. E. Stricklin	2.17	330
May 16	Batchelder and Stricklin. [a]	2.53	458	Aug. 4	do	1.99	282
June 10	Stricklin and Donnelly	2.87	563	11	do	1.81	242
July 8	C. E. Stricklin	2.72	499	Sept. 2	do	1.59	180

[a] Assistants to State engineer.

Daily discharge, in second-feet, of East Fork of Hood River near Mount Hood, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	188	174	174	150	148	143	180	294	540	505	302	199
2	183	184	176	168	158	149	178	297	505	560	300	203
3	181	186	192	170	174	137	170	300	470	580	313	199
4	177	210	182	174	170	152	182	297	452	600	292	194
5	175	180	178	203	168	158	223	302	452	580	282	194
6	175	178	170	172	166	143	223	358	488	560	277	190
7	174	172	168	164	164	143	274	421	540	540	267	184
8	168	172	170	160	162	142	274	452	620	540	260	188
9	166	196	162	158	160	140	253	522	660	560	265	188
10	168	184	160	156	158	137	246	540	580	540	258	196
11	172	164	160	154	158	137	255	580	505	560	270	190
12	174	148	166	152	160	136	241	560	488	560	270	184
13	175	148	164	150	158	136	232	540	488	522	274	176
14	179	152	156	146	156	132	227	540	540	505	272	172
15	181	156	152	143	160	132	221	505	620	540	262	196
16	188	158	162	136	196	131	212	452	660	560	260	216
17	190	168	154	136	172	132	203	432	643	560	253	214
18	184	164	158	138	170	136	199	407	626	560	260	214
19	181	158	160	144	166	137	201	400	608	540	253	210
20	181	154	158	144	162	138	216	397	591	505	253	210
21	179	156	160	144	158	138	221	400	574	452	265	203
22	174	160	154	140	156	138	223	404	557	414	262	188
23	168	158	154	138	154	146	353	418	540	376	241	166
24	168	156	152	138	152	154	270	421	535	346	241	170
25	168	194	150	140	149	146	349	404	530	334	250	160
26	168	178	148	140	149	143	382	432	525	361	234	176
27	172	265	144	160	146	172	367	470	520	361	229	180
28	162	201	144	150	144	199	346	522	515	334	210	178
29	176	182	144	146	.....	232	331	560	510	302	210	188
30	180	178	143	144	.....	196	310	560	505	292	212	180
31	201	.....	144	146	.....	180	.....	540	.....	294	210	.....

Digitized by Google

Monthly discharge of East Fork of Hood River near Mount Hood, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	201	162	177	10,900
November	265	148	174	10,400
December	192	143	160	9,840
January	203	136	152	9,350
February	196	144	160	8,890
March	232	131	150	9,220
April	382	170	252	15,000
May	580	294	443	27,200
June	660	452	546	32,500
July	600	292	479	29,500
August	313	210	258	15,900
September	216	160	190	11,300
The year	660	131	262	190,000

EAST FORK OF HOOD RIVER NEAR DEE, OREG.

LOCATION.—Near center of sec. 18, T. 1 N., R. 10 E., about one-eighth mile below Trout Creek, one-fourth mile above junction with Middle Fork, and 1¼ miles above Dee, Hood River County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 26 to August 24, 1917, when station was discontinued.

GAGE.—Stevens 8-day water-stage recorder on right bank.

DISCHARGE MEASUREMENTS.—Made from cable one-eighth mile above gage.

CHANNEL AND CONTROL.—Boulders and gravel; permanent during medium and low stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded June 26 to August 24, 2.05 feet at 10 p. m. July 4 (discharge, 560 second-feet); minimum stage recorded, 1.07 feet at 5 p. m. August 22 and 23 (discharge, 119 second-feet).

ICE.—None.

DIVERSIONS.—Several hundred acres irrigated above the station from the Glacier, Mount Hood, and other ditches. East Fork Irrigation District canal diverts water outside the drainage basin.

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting the recorder graph. Records excellent.

Discharge measurements of East Fork of Hood River near Dee, Oreg., during the year ending Sept. 30, 1917.

[Made by C. E. Stricklin, assistant to State engineer.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 30	1.82	437	July 24	1.44	242	Sept. 3	1.03	108
July 19	1.77	392	Aug. 3	1.31	188			
22	1.56	288	10	1.17	146			

Digitized by Google

Daily discharge, in second-feet, of East Fork of Hood River near Dee, Oreg., for the period June 26 to Aug. 24, 1917.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1	.....	446	201	11	.....	458	146	21	.....	360	146
2	.....	482	197	12	.....	452	151	22	.....	325	132
3	.....	506	204	13	.....	428	148	23	.....	288	126
4	.....	512	197	14	.....	405	143	24	.....	248	134
5	.....	506	183	15	.....	428	143	25	.....	227	.....
6	.....	482	180	16	.....	440	146	26	422	252	.....
7	.....	458	170	17	.....	440	148	27	458	261	.....
8	.....	452	137	18	.....	434	140	28	482	236	.....
9	.....	482	137	19	.....	428	146	29	476	212	.....
10	.....	452	143	20	.....	400	148	30	446	197	.....
								31	.....	197	.....

Monthly discharge of East Fork of Hood River near Dee, Oreg., for the period June 26 to Aug. 24, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
June 26-30	482	422	457	4,530
July	512	197	384	23,600
August 1-24	201	126	156	7,430

EAST FORK IRRIGATION DISTRICT CANAL, NEAR MOUNT HOOD, OREG.

LOCATION.—In SE. ¼ sec. 33, T. 1 N., R. 10 E., 1 mile below intake, about 1½ miles south of Mount Hood post office, and 2 miles east of Parkdale station on Mount Hood Railroad.

RECORDS AVAILABLE.—June 17, 1913, to October 26, 1914; July 21, 1915, to September 30, 1917.

GAGE.—Stevens eight-day water-stage recorder on left side of canal just above road crossing. Observers, F. A. McDonald and C. H. Shaw. Vertical staff on side of flume, 1,000 feet downstream, in the SW. ¼ sec. 34, used up to October, 1914.

DISCHARGE MEASUREMENTS.—Made from highway bridge or by wading.

CHANNEL AND CONTROL.—Smooth earth section. Head of flume probably acts as control; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and during 1915 to 1917, 3.35 feet at 2 a. m. July 17 (discharge, 143 second-feet). Canal dry at various times.

ICE.—No water carried in cold weather.

ACCURACY.—Stage-discharge relation practically permanent during irrigation season. Rating curve used October 1 to 29 well defined; curve used April 16 to September 30, well defined between 20 and 140 second-feet. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting gage-height graph. Records excellent.

The East Fork Irrigation District canal diverts water in the SW. ¼ sec. 4, T. 1 S., R. 10 E., and irrigates lands lying east of Hood River. Most of the return water reaches Odell and Neal creeks and the lower part of Hood River.

Digitized by Google

Discharge measurements of East Fork Irrigation District canal near Mount Hood, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 25	Luper[a] and Donnelly[a]	1.46	21.8	June 21	C. E. Stricklin	2.88	100
May 15	C. E. Stricklin[a]	1.62	24.3	July 10	do	3.03	113
June 10	Stricklin and Donnelly	2.55	79	22	do	3.18	131

[a] Assistant to State engineer.

Daily discharge, in second-feet, of East Fork Irrigation District canal near Mount Hood, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Apr.	May.	June.	July.	Aug.	Sept.
1	54	.....	13	30	120	129	116
2	54	.....	12	31	120	129	110
3	53	.....	16	32	120	129	110
4	42	.....	16	32	120	120	105
5	30	.....	16	40	120	120	102
6	30	.....	16	48	116	120	102
7	30	.....	17	67	116	116	98
8	30	.....	17	82	120	120	97
9	30	.....	17	83	120	124	98
10	30	.....	16	77	116	120	78
11	30	.....	17	78	120	120	64
12	31	.....	20	82	120	120	53
13	31	.....	19	85	120	124	49
14	31	.....	22	92	124	124	50
15	0	.....	26	98	129	124	47
16	0	9	26	104	138	129	43
17	10	9	26	105	143	129	38
18	12	9	26	103	138	124	36
19	12	11	26	104	134	124	36
20	13	10	24	102	134	124	36
21	15	11	25	104	129	129	36
22	15	12	26	84	129	124	34
23	19	12	27	97	129	124	34
24	21	12	27	107	129	124	34
25	21	13	27	116	129	120	35
26	22	13	27	116	134	120	34
27	22	13	.....	116	134	116	34
28	21	13	7	120	129	120	34
29	8	13	22	120	124	120	34
30	.....	13	25	116	120	120	55
31	.....	.....	28	.....	116	120	.....

NOTE.—No discharge Oct. 30 to Apr. 15, inclusive.

Monthly discharge of East Fork Irrigation District canal near Mount Hood, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October (27 days)	54	8	26.6	1,420
April (15 days)	13	9	11.5	342
May (30 days)	28	7	21.0	1,250
June	120	30	85.7	5,100
July	143	116	125	7,690
August	129	116	123	7,560
September	116	34	61.1	3,640
The year	.....	.....	.....	27,000

Digitized by Google

PACIFIC POWER & LIGHT CO.'S TAILRACE NEAR HOOD RIVER, OREG.

LOCATION.—In SE. ¼ sec. 36, T. 3 N., R. 10 E., just below power house, opposite upper gage on Hood River, three-quarters of a mile south of Hood River, Hood River County.

RECORDS AVAILABLE.—October 1, 1913, to September 30, 1914; January 1, 1916, to September 30, 1917.

GAGE.—Vertical staff on right bank of tailrace, at different datum from that of gage used 1913 to 1914. Gage reader, A. Rogers.

DISCHARGE MEASUREMENTS.—Made from footbridge just below gage.

CHANNEL AND CONTROL.—Flume 11 feet wide extends a few feet down from gage; below this the canal is excavated in gravel.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 2.0 feet several times during year (discharge, 97 second-feet). Canal dry at various times.

1913–14 and 1916–17: Maximum discharge, 110 second-feet (determined from electric output February 20, 1914). Canal practically dry at times.

ICE.—Never any ice here.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Gage read to half-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table except when there was a great difference in the two readings for the day. For such days discharge is average of values obtained by applying both gage heights to rating table. Records good.

The Pacific Power & Light Co.'s canal diverts water from Hood River at a dam in the NE. ¼ sec. 1, T. 2 N., R. 10 E., to a power plant in the SE. ¼ sec. 36, T. 3 N., and the tailrace discharges back into the river in the NE. ¼ sec. 36, below gage on Hood River at Powderdale and above gage at bridge.

The following discharge measurement was made by C. E. Stricklin, assistant to State engineer:

June 12, 1917: Gage height, 1.70 feet; discharge, 76 second-feet.

Daily discharge, in second-feet, of Pacific Power & Light Co.'s tailrace near Hood River Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Sept.
1	80	73	.....	70	97	73	40	40	90	14	.....
2	82	73	.....	70	97	80	.....	40	86	64	.....
3	82	73	.....	94	97	76	90	40	14	73	.....
4	83	70	.....	94	40	50	83	40	.....	10	.....
5	80	70	35	94	90	67	80	70	.....	70	.....
6	82	70	.....	97	97	55	76	14	10	67	.....
7	80	67	94	64	97	58	80	80	10	70	.....
8	47	73	94	97	94	83	40	64	10	14	.....
9	85	73	94	97	90	86	76	70	40	.....	.....
10	83	67	14	90	52	90	80	70	83	97	.....
11	83	.....	86	94	40	86	80	67	70	70	.....
12	83	86	86	94	20	90	80	67	70	73	.....
13	83	86	86	83	.....	97	83	14	67	73	.....
14	83	86	47	14	.....	.....	80	.....	70	64	.....
15	80	86	14	94	38	.....	40	64	70	18	.....
16	83	86	6	94	80	80	40	64	67	67	.....
17	83	86	3	90	76	40	83	6	3	64	18
18	83	86	3	97	40	73	80	6	70	70	18
19	83	80	3	97	83	76	83	6	64	70	.....
20	80	76	3	94	73	40	76	6	70	97	.....
21	76	76	3	40	80	40	80	6	70	90	50
22	83	76	70	94	76	90	70	6	70	86	32
23	76	73	14	94	52	86	73	6	70	90	32
24	80	73	76	94	58	61	73	6	67	93	76
25	76	67	14	97	58	40	70	6	67	90	48
26	83	64	14	97	70	83	73	6	70	90	49
27	83	34	14	97	76	80	73	97	14	.....	51
28	83	.....	76	73	76	80	70	83	42	.....	48
29	83	.....	76	97	.....	83	14	83	67	.....	52
30	83	.....	76	64	.....	83	40	83	67	.....	49
31	83	.....	14	97	.....	76	.....	90	.....	.....	.....

NOTE.—No flow on days for which discharge is not given.

Digitized by Google

Monthly discharge of Pacific Power & Light Co.'s tailrace near Hood River, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	85	47	80.5	4,950
November (26 days)	86	34	74.2	3,830
December (26 days)	94	3	42.9	2,210
January	97	14	85.9	5,280
February (26 days)	97	20	71.0	3,660
March (29 days)	97	40	72.5	4,170
April (29 days)	90	14	69.2	3,980
May (30 days)	97	6	43.3	2,580
June (28 days)	90	3	56.0	3,110
July (25 days)	97	10	67.4	3,340
September (12 days)	76	18	43.6	1,040
The year				37,800

WHITE SALMON RIVER BASIN.

WHITE SALMON RIVER AT SPLASH DAM NEAR TROUT LAKE, WASH.

LOCATION.—In NE. ¼ sec. 6, T. 5 N., R. 11 E., at splash dam formerly used by Wind River Lumber Co., 2½ miles south of Trout Lake, Klickitat County, 4 miles below mouth of Trout Creek, and about 10 miles north of Husum.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 1, 1912, to September 30, 1917.

GAGE.—Vertical staffs in the pond above the dam, except June 1 to September 30, 1912, and May 23 to June 28, 1913, during which periods gage readings were made on vertical staff on right bank just below dam, Gage reader, H. G. Williams, sr.

DISCHARGE MEASUREMENTS.—Made from a cable 800 feet below the dam.

CHANNEL AND CONTROL.—For the gage above the dam the control is formed by two sharp-crested weirs and an overflow opening; below the dam, rocks and gravel; somewhat shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.15 feet at 7 a. m. May 30 (discharge, 1,370 second-feet); minimum stage recorded, 1.82 feet December 29 (discharge, 117 second-feet).

1912–1917: Maximum stage recorded, 7.65 feet at 7. a. m. April 3, 1915 (discharge, 2,160 second-feet); minimum stage recorded, 1.05 feet August 1, 4, 5, and 6, 1915 (discharge, 52 second-feet).

ICE.—Stage-discharge relation unaffected by ice, but it is occasionally impossible to read gage when it is covered with ice and snow.

DIVERSIONS.—A considerable quantity of water is diverted for irrigation above the station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed by log hitting weir April 28. Rating curve used October 1 to April 27 fairly well defined between 125 and 700 second-feet. Curve used April 28 to September 30 fairly well defined. Gage read to quarter-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good October to March, August, and September; fair April and July.

Digitized by Google

Discharge measurements of White Salmon River at splash dam near Trout Lake, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 27	W. E. Dickinson	2.15	151	Aug. 24	C. L. Batchelder	1.09	155
May 19	C. L. Batchelder	4.74	910	Oct. 20	do	1.00	149

Daily discharge, in second-feet, of White Salmon River at splash dam near Trout Lake, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	160	186	191	135	135	135	186	600	1,260	750	202	178
2	154	186	200	147	147	141	191	600	1,170	750	202	168
3	160	215	215	147	154	141	173	600	1,020	780	202	168
4	154	365	200	147	180	147	180	575	960	810	190	168
5	154	265	186	200	173	160	215	600	900	780	178	168
6	154	215	180	208	173	154	230	625	930	750	178	158
7	160	200	173	186	160	147	345	725	1,050	700	178	158
8	154	186	166	173	160	141	440	810	1,110	650	168	168
9	147	230	160	180	160	141	415	930	1,200	650	178	168
10	147	245	154	186	154	135	390	1,080	1,110	625	190	168
11	154	200	154	173	160	135	440	1,230	960	600	178	168
12	154	160	160	160	173	135	415	1,200	840	575	178	168
13	154	173	166	160	173	135	390	1,170	810	550	168	168
14	147	166	160	166	166	130	390	1,140	900	502	158	168
15	154	160	147	130	166	130	365	1,110	990	526	168	168
16	154	180	147	130	186	125	365	1,020	1,050	526	178	168
17	154	173	147	130	186	125	345	960	1,050	526	190	168
18	135	186	147	135	173	135	345	900	1,020	526	168	168
19	154	173	147	135	180	135	325	900	1,020	458	168	178
20	160	166	147	154	173	135	345	930	990	414	168	178
21	160	160	154	147	166	135	390	960	960	374	168	178
22	147	173	147	147	160	135	365	960	900	338	168	168
23	147	173	141	141	154	141	390	960	810	306	168	168
24	147	166	135	141	160	154	440	990	900	290	158	158
25	147	191	141	147	147	135	520	960	900	258	168	168
26	154	208	135	154	154	135	640	930	840	242	158	168
27	154	265	130	160	160	147	700	1,050	810	258	168	168
28	147	265	125	147	147	186	700	1,200	840	242	168	178
29	154	215	117	147	.....	265	700	1,340	810	202	168	168
30	166	200	135	125	.....	230	650	1,340	810	202	168	168
31	230	.....	147	123	.....	200	.....	1,260	.....	202	168	.....

Monthly discharge of White Salmon River at splash dam near Trout Lake, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	230	135	155	9,530
November	365	160	202	12,000
December	215	117	157	9,659
January	208	123	154	9,470
February	186	135	164	9,110
March	265	125	149	9,160
April	700	173	400	23,800
May	1,340	575	957	58,800
June	1,260	810	964	57,400
July	810	202	496	30,500
August	202	158	175	10,800
September	178	158	169	10,100
The year	1,340	117	345	250,000

Digitized by Google

WHITE SALMON RIVER AT HUSUM, WASH.

LOCATION.—In SE. ¼ sec. 25, T. 4 N., R. 10 E., 1,000 feet above falls and power house at Husum, Klickitat County, and three-quarters of a mile above Rattlesnake Creek.

DRAINAGE AREA.—300 square miles.

RECORDS AVAILABLE.—September 23, 1909, to September 30, 1917.

GAGE.—Vertical staff on right bank; read by John Wassell. Fuller water-stage recorder used October, 1912, to February, 1915.

DISCHARGE MEASUREMENTS.—Made from cable 100 feet below gage.

CHANNEL AND CONTROL.—Gravel and lava boulders; practically permanent. Control is crest of falls, which is sometimes obstructed by logs, causing backwater.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.55 feet, May 29 (discharge, 2,220 second-feet); minimum stage recorded, 2.98 feet, January 15 (discharge, 537 second-feet).

1909-1917: Maximum stage recorded, 7.65 feet at 7 a. m., November 24, 1909 (discharge, 4,340 second-feet); minimum stage recorded, 2.66 feet at 2 p. m., September 30, 1915 (discharge, 432 second-feet).

ICE.—Stage-discharge relation practically unaffected by ice.

DIVERSIONS.—Several ditches divert water for irrigation in Trout Lake Valley.

REGULATION.—None. Flow formerly affected at times by operation of splash dam 10 miles upstream; no logging on stream at present.

ACCURACY.—Stage-discharge relation permanent during year. Rating curve well defined. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage height to rating table, except for April 2, for which dischange has been interpolated. Records good.

Discharge measurements of White Salmon River at Husum, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 27	W. E. Dickinson	3.35	698
May 19	C. L. Batchelder	4.62	1,460
Aug. 24	do	3.60	825

Digitized by Google

Daily discharge, in second-feet, of White Salmon River at Husum, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	820	720	675	585	565	545	820	1,170	2,060	1,580	990	820
2	820	720	720	585	565	565	750	1,110	1,900	1,580	990	820
3	770	720	720	585	585	545	720	1,170	1,740	1,660	990	820
4	770	990	720	608	608	585	720	1,110	1,660	1,740	930	820
5	770	720	675	630	608	585	720	1,110	1,580	1,660	930	820
6	770	770	675	675	608	585	770	1,170	1,370	1,580	930	820
7	770	720	630	630	608	585	930	1,300	1,580	1,510	930	820
8	770	720	630	630	608	630	1,110	1,370	1,900	1,510	870	820
9	770	720	630	630	608	630	1,050	1,580	1,900	1,510	870	770
10	770	770	630	630	585	608	1,050	1,740	1,900	1,440	930	770
11	770	720	630	630	608	608	1,110	1,900	1,740	1,440	930	770
12	720	720	630	630	630	585	1,050	1,900	1,510	1,370	930	770
13	720	675	630	585	608	565	1,050	1,820	1,440	1,370	930	770
14	720	630	675	565	608	565	990	1,740	1,740	1,300	870	770
15	720	630	630	545	608	565	930	1,660	1,900	1,300	870	770
16	720	630	630	545	630	545	930	1,580	1,980	1,300	870	770
17	720	675	608	565	630	545	930	1,510	1,900	1,300	870	720
18	720	675	608	565	630	565	930	1,440	1,900	1,300	870	720
19	720	675	630	565	630	565	930	1,440	1,900	1,230	930	770
20	720	630	630	585	630	565	870	1,510	1,900	1,170	870	770
21	720	630	630	585	585	545	870	1,510	1,740	1,170	870	720
22	675	675	630	585	608	565	930	1,510	1,660	1,110	870	720
23	675	630	630	585	608	585	930	1,580	1,580	1,110	870	720
24	675	630	608	585	608	630	990	1,580	1,740	1,050	870	630
25	675	675	585	565	608	630	1,110	1,580	1,740	1,050	820	675
26	675	770	585	565	630	630	1,230	1,510	1,580	1,050	820	675
27	675	720	585	630	630	630	1,300	1,580	1,660	1,050	820	675
28	675	720	565	585	565	675	1,300	1,900	1,660	1,050	820	675
29	675	720	565	565	.....	930	1,230	2,220	1,660	1,050	820	675
30	720	720	565	545	.....	870	1,230	2,060	1,580	1,050	820	675
31	770	.....	585	565	.....	770	.....	2,060	.....	990	820	.....

Monthly discharge of White Salmon River at Husum, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	820	675	731	44,900
November	990	630	704	41,900
December	720	565	630	38,700
January	675	545	591	36,300
February	630	565	607	33,700
March	930	545	613	37,700
April	1,300	720	983	58,500
May	2,220	1,110	1,560	95,900
June	2,060	1,440	1,740	104,000
July	1,740	990	1,310	80,600
August	990	820	888	54,600
September	820	630	751	44,700
The year	2,220	545	927	672,000

WHITE SALMON RIVER NEAR UNDERWOOD, WASH.

LOCATION.—In NW. ¼ sec. 14, T. 3 N., R. 10 E., in Klickitat County, about 200 yards below Northwestern Electric Co.'s power plant, 2½ miles north of Underwood.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 11, 1915 to September 30, 1917; also October 18, 1912, to February 26, 1913, at dam about a mile above.

GAGE.—Friez water-stage recorder on left bank since January 30, 1916; Fuller recorder prior to that date; inspected by D. J. Shore, foreman of power plant, and by other employees.

DISCHARGE MEASUREMENTS.—Made from cable at gage; measuring conditions good.

CHANNEL AND CONTROL.—Rock and gravel; practically permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 30 feet at 6.0 a. m. June 9 (discharge, 2,130 second-feet); minimum discharge not determined; occurs when power plant is shut down.

1915–1917: Maximum stage recorded, 5.0 feet at 3 a. m. March 21, 1916 (discharge, 4,100 second-feet); minimum discharge not determined; occurs when power plant is shut down.

ICE.—Stage-discharge relation not affected.

DIVERSIONS.—Several ditches divert water for irrigation in Trout Lake Valley.

REGULATION.—At low and medium stages practically all the water is used through the wheels of the power plant. The pond above the dam covers about 83 acres and is drawn down 6 or 8 feet at times.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 600 and 3,000 second-feet; fairly well defined between 300 and 600 second-feet. Operation of water-stage recorder unsatisfactory. Daily discharge ascertained by use of discharge integrator or by averaging discharge for two-hour intervals. Discharge for periods for which gage-height record is missing or impossible of interpretation has been determined from record of electrical output of power plant. Curve of relation of output to discharge is fairly well defined. Records good except for periods estimated. (See footnote to table of daily discharge.)

Discharge measurements of White Salmon River near Underwood, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 28	W. E. Dickinson	1.10	726
Nov. 3	C. L. Batchelder	1.36	936
May 19	do	2.32	1,550

Daily discharge, in second-feet, of White Salmon River near Underwood, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	871	a710	b800	760	a660	a710	1,140	1,400	1,950	1,630	1,070	a910
2	865	a740	b730	b770	a700	a620	1,190	1,430	b1,900	1,690	1,070	660
3	865	a730	853	b780	a740	a770	1,120	1,410	b1,840	1,680	b1,060	860
4	869	1,010	861	800	923	b400	1,140	1,370	1,790	1,750	b1,050	1,040
5	843	b800	826	860	900	a760	1,230	1,410	1,800	1,620	b1,040	a950
6	842	a650	772	960	860	a810	1,260	1,550	1,810	1,600	b1,020	a870
7	835	a690	b750	900	a850	a840	1,590	1,670	1,910	1,430	a1,010	a790
8	b670	a700	b730	860	a860	a840	1,630	1,830	1,990	1,470	a1,010	a720
9	a760	a710	710	800	a750	a720	1,560	1,890	2,130	.....	a1,040	a650
10	a770	a720	617	810	a690	a720	1,550	2,010	b1,960	.....	a990	a730
11	a760	a680	720	780	a720	a620	1,520	1,970	b1,800	.....	b990	a890
12	a740	a600	a720	830	a650	a590	1,450	.....	1,630	.....	b990	a840
13	a750	a600	a720	720	a740	a820	1,370	.....	1,660	.....	b980	a820
14	a740	a610	a700	a570	a800	a840	1,370	.....	1,750	.....	a980	a890
15	b620	b630	a700	a650	a770	a630	1,320	.....	1,880	1,420	a940	a930
16	a710	a640	a710	a660	a810	a780	b1,290	.....	1,950	1,380	b920	a550
17	a780	a660	620	a640	a790	a600	b1,250	.....	.....	1,340	a910	a710
18	a770	a670	a720	a640	a550	b500	1,220	.....	.....	1,280	a910	a850
19	a780	b550	a740	a680	800	a760	1,160	.....	.....	1,270	b800	a780
20	a760	a620	a730	a700	a810	a780	1,230	1,660	.....	1,230	1,030	a830
21	a760	a690	a720	778	a820	a820	b1,300	1,700	.....	b1,200	960	a810
22	b630	a730	a740	755	a780	a570	b1,300	1,680	.....	b1,180	918	a870
23	a710	a730	a710	747	a730	a800	b1,400	1,690	.....	b1,150	932	a450
24	a750	a700	700	737	a640	1,030	b1,400	1,730	1,790	1,130	895	a740
25	a740	760	770	723	a640	973	1,490	1,720	1,690	1,090	a890	a710
26	a770	833	700	701	a710	928	1,540	1,710	1,580	1,100	810	a760
27	a770	945	a670	607	a780	1,150	1,620	1,920	1,580	1,000	980	a770
28	a750	873	a630	670	a650	1,400	1,560	2,000	1,580	b1,090	a920	a750
29	b610	795	a610	703	.....	1,280	1,520	2,020	1,570	b,080	a920	a810
30	a730	b780	a600	740	.....	1,210	1,490	2,030	1,560	1,070	a930	a470
31	a720	.....	620	a780	.....	b1,000	.....	2,020	.....	1,071	a930	.....

a Computed from electric output of power plant. b Estimated.

NOTE.—Mean discharge estimated: May 12–19, 1,700 second-feet;. June 17–23, 1,870 second-feet; July 9–14, 1,440 second-feet.

Digitized by Google

Monthly discharge of White Salmon River near Underwood, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	871	610	759	46,700
November	1,010	550	719	42,800
December	861	600	716	44,000
January	960	570	746	45,900
February	923	550	754	41,900
March	1,400	400	815	50,100
April	1,630	1,120	1,370	81,500
May	2,030	1,370	1,720	106,000
June	2,130	1,560	1,840	109,000
July	1,750	1,070	1,340	82,400
August	1,070	800	964	59,300
September	1,040	450	780	46,400
The year	2,130	400	1,050	756,000

SANDY RIVER BASIN.

SANDY RIVER BELOW DAM NEAR MARMOT, OREG.

LOCATION.—In NE. ¼ sec. 13, T. 2 S., R. 5 E., a quarter of a mile below diversion dam for Bull Run plant of Portland Railway, Light & Power Co., about a mile southwest of Marmot, Clackamas County, and 9 miles east of Bull Run.

DRAINAGE AREA.—267 square miles at cable (measured on Mount Hood topographic map and on map of Oregon National Forest).

RECORDS AVAILABLE.—December 22, 1915, to September 30, 1917. When discharge of Sandy River canal is added the records are directly comparable with those at station above dam near Marmot, August 15, 1911, to December 21, 1915.

GAGE.—Vertical staff installed in gage well on right bank October 16, 1916; Stevens 8-day water-stage recorder installed December 9, 1916. Observer, O. G. Olson. Gage above crest of dam used December 22, 1915, to October 15, 1916.

DISCHARGE MEASUREMENTS.—Made from cable near upper end of backwater of dam (discharge of Sandy River canal deducted) or by wading near gage.

CHANNEL AND CONTROL.—Gravel and boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 9.0 feet at 1.30 p. m. November 27 (discharge, 7,700 second-feet); minimum stage recorded, 0.37 foot October 26 (discharge, 9 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—Sandy River canal of Portland Railway, Light & Power Co. takes out at dam. Its flow is included with that of river to give total run-off.

REGULATION.—The storage back of dam serves to lessen diurnal fluctuation caused by melting glaciers but has no effect for period of a day or over.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined. Gage read once a day to hundredths October 16 to November 4; twice a day to hundredths November 5 to December 9. Operation of water-stage recorder satisfactory after December 9, except April 25 to 27 and July 8 to 13. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting the gage-height graph, or for days when there was considerable fluctuation, by averaging discharge obtained by applying to rating table the mean gage heights for various subdivisions of the day. Records excellent.

Digitized by Google

Discharge measurements of Sandy River below dam near Marmot, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 16	F. F. Henshaw	0.39	[a] 12.9	May 10	C. L. Batchelder	7.00	[b] 3,650
Dec. 12	C. L. Batchelder	4.08	[b] 1,040	Aug. 7	F. F. Henshaw	2.04	[a] 251
Jan. 28	Batchelder and Briggs	4.88	[b] 1,590				

[a] Measurement made by wading near gage.
[b] Measurement made above dam and canal deducted.

Daily discharge, in second-feet, of Sandy River below dam near Marmot, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	345	1,340	458	702	422	2,050	2,320	4,120	1,970	389	78
2	.....	302	1,250	1,280	795	405	1,540	2,230	3,410	1,970	345	230
3	.....	515	1,400	1,810	1,220	422	1,370	2,230	3,410	1,970	305	190
4	.....	1,370	1,510	1,920	1,370	682	1,480	2,140	2,930	1,890	290	70
5	.....	795	1,340	3,960	1,480	1,310	3,040	2,050	2,930	1,730	272	60
6	.....	770	1,310	2,710	1,540	920	2,710	2,920	3,280	1,620	255	40
7	.....	820	870	2,140	1,540	795	3,820	5,200	3,960	1,480	242	18
8	.....	770	895	1,620	1,440	702	3,820	4,440	4,280	1,350	228	33
9	.....	1,480	870	1,340	1,280	652	2,930	4,620	5,000	1,300	230	37
10	.....	1,970	748	1,190	1,190	615	2,510	3,960	4,120	1,240	210	38
11	.....	1,250	680	1,100	1,340	575	2,820	3,820	3,540	1,420	215	202
12	.....	820	990	970	1,810	555	2,410	3,960	2,930	1,130	235	52
13	.....	680	1,890	845	1,650	535	1,970	3,680	3,160	1,080	218	43
14	.....	535	1,480	748	1,370	495	1,970	3,410	4,120	1,020	398	64
15	.....	444	1,160	652	1,250	458	1,730	2,950	4,620	1,040	595	92
16	10	345	995	595	2,020	466	1,510	2,410	4,800	1,070	615	55
17	10	312	895	555	1,730	475	1,320	2,230	4,280	1,020	635	146
18	10	345	870	515	1,400	535	1,220	2,320	3,680	970	595	84
19	10	290	1,160	495	1,190	555	1,280	2,510	3,540	920	575	77
20	10	238	1,480	495	1,040	575	1,650	2,710	3,280	845	555	72
21	10	225	1,580	515	945	555	1,970	3,160	3,410	770	575	93
22	10	210	1,280	458	845	555	1,810	2,820	2,960	702	535	30
23	10	235	1,020	495	748	732	2,610	2,610	2,510	635	447	44
24	10	205	870	458	702	1,540	2,820	2,580	2,710	595	242	38
25	9	1,250	748	732	635	1,100	4,440	2,540	2,510	575	240	45
26	9	2,050	652	870	555	920	5,000	2,510	2,410	615	134	59
27	10	3,960	595	1,830	595	1,710	4,200	2,820	2,320	635	82	161
28	12	2,710	535	1,620	458	2,320	3,410	3,410	2,410	575	72	93
29	10	1,890	495	1,190	.....	3,040	2,930	4,120	2,230	515	75	58
30	225	1,730	458	920	32,840	2,050	2,410	3,820	1,970	405	70	37
31	555	.....	440	770	.....	1,480	.....	3,960	.....	458	67	.....

NOTE.—Mean discharge, Oct. 1-15, estimated 12 second-feet.

Monthly discharge of Sandy River below dam near Marmot, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	555	9	35.5	2,180
November	3,960	205	962	57,200
December	1,890	440	1,030	63,300
January	3,960	458	1,140	70,100
February	2,020	458	1,170	65,000
March	3,040	405	908	55,800
April	5,000	1,220	2,490	148,000
May	5,200	2,050	3,110	191,000
June	5,000	1,970	3,360	200,000
July	1,970	405	1,080	66,400
August	635	67	321	19,700
September	230	18	78.0	4,640
The year	5,200	9	1,300	943,000

Digitized by Google

Combined daily discharge, in second-feet, of Sandy River and canal near Marmot, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	400	589	1,500	726	938	738	2,290	2,500	4,130	2,150	759	450
2	392	546	1,400	1,560	1,030	721	1,780	2,410	3,420	2,190	745	424
3	376	759	1,620	2,110	1,460	738	1,610	2,400	3,420	2,190	737	463
4	376	1,610	1,720	2,220	1,620	998	1,720	2,310	2,940	2,110	722	484
5	368	1,000	1,550	4,280	1,730	1,630	3,250	2,300	2,940	1,950	695	474
6	368	971	1,520	3,020	1,790	1,240	2,880	3,170	3,290	1,840	678	472
7	360	1,020	1,110	2,450	1,790	1,110	3,990	5,250	3,970	1,760	665	450
8	360	964	1,160	1,920	1,680	1,030	3,990	4,530	4,300	1,700	651	501
9	352	1,630	1,150	1,640	1,520	976	2,940	4,720	5,050	1,650	653	487
10	344	2,080	1,030	1,480	1,430	939	2,530	4,060	4,160	1,590	633	488
11	344	1,400	964	1,390	1,580	899	2,860	3,920	3,580	1,540	638	652
12	352	1,030	1,270	1,250	2,060	879	2,450	4,060	2,970	1,480	658	484
13	352	888	2,190	1,130	1,890	859	2,050	3,780	3,250	1,430	686	475
14	352	779	1,780	1,030	1,610	811	1,990	3,510	4,290	1,370	650	514
15	360	728	1,450	936	1,490	774	1,840	3,050	4,790	1,390	596	533
16	366	629	1,130	879	2,270	782	1,660	2,590	4,970	1,420	616	487
17	366	596	1,180	831	1,970	791	1,490	2,510	4,450	1,360	636	484
18	358	645	1,150	791	1,640	851	1,400	2,600	3,850	1,310	596	480
19	342	606	1,440	771	1,430	879	1,460	2,790	3,710	1,250	576	473
20	342	554	1,770	771	1,280	899	1,830	2,990	3,450	1,180	556	468
21	342	533	1,870	791	1,180	879	2,150	3,280	3,580	1,100	576	465
22	334	518	1,570	734	1,080	879	1,990	2,830	3,130	1,030	536	462
23	334	551	1,310	771	984	1,060	2,800	2,620	2,650	967	578	476
24	326	513	1,150	734	946	1,840	3,010	2,590	2,880	919	590	470
25	325	1,490	1,030	1,020	887	1,410	4,660	2,550	2,640	899	588	468
26	325	2,220	936	1,160	847	1,100	5,120	2,520	2,510	939	566	491
27	366	4,050	871	2,060	787	1,950	4,310	2,830	2,420	959	496	494
28	376	2,740	811	1,790	774	2,560	3,540	3,420	2,460	899	486	516
29	390	1,910	771	1,360	.....	3,300	3,080	4,130	2,360	831	489	481
30	549	1,900	726	1,120	.....	2,290	2,570	3,830	2,120	777	484	460
31	847	.....	708	1,010	.....	1,720	.....	3,970	.....	768	499	.....

Combined monthly discharge of Sandy River and canal near Marmot, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 267 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	847	325	379	1.42	1.64	23,300
November	4,050	513	1,180	4.42	4.93	70,200
December	2,190	708	1,280	4.80	5.53	78,700
January	4,280	726	1,410	5.28	6.09	86,700
February	2,270	774	1,420	5.32	5.54	78,900
March	3,300	721	1,210	4.53	5.22	74,400
April	5,120	1,400	2,640	9.89	11.03	157,000
May	5,250	2,300	3,230	12.1	13.95	199,000
June	5,050	2,120	3,460	13.0	14.50	206,000
July	2,190	768	1,390	5.21	6.01	85,500
August	759	484	614	2.30	2.65	37,800
September	652	424	484	1.81	2.02	28,800
The year	5,250	325	1,550	5.81	79.11	1,130,000

LOST CREEK NEAR BRIGHTWOOD, OREG.

LOCATION.—In NE. ¼ sec. 25, T. 2 S., R. 7 E., about 100 yards above mouth, 1 mile southeast of Truman's ranch, and 8 miles east of Brightwood, Clackamas County.

DRAINAGE AREA.—11.2 square miles (measured on topographic map).

RECORDS AVAILABLE.—September 17, 1913, to September 30, 1917.

GAGE.—Stevens continuous water-stage recorder referred to a vertical staff on left bank. Observer, Carl Raithel.

Digitized by Google

DISCHARGE MEASUREMENTS.—Made from foot log or by wading.

CHANNEL AND CONTROL.—Gravel and boulders; may shift in floods.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder 2.48 feet at 9.40 a. m. November 27 (discharge, 485 second-feet); minimum stage recorded 0.40 foot September 30 (discharge, 19 second-feet).

1913-1917: Maximum stage recorded, 3.75 feet December 22, 1915 (discharge, 1,330 second-feet); minimum stage recorded, 0.38 foot September 25, 1915 (discharge, 15 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATIONS.—None.

ACCURACY.—Stage-discharge relation practically permanent. However, a new rating curve, fairly well defined, has been drawn up averaging all late measurements. Operation of water-stage recorder somewhat unsatisfactory, as water in river has not had free access to well at times. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging discharge for bi-hourly periods. Records good.

Discharge measurements of Lost Creek near Brightwood, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.ft.*
May 9	C. L. Batchelder	2.06	290
Aug. 6	F. F. Henshaw	.67	30.2

Daily discharge, in second-feet, of Lost Creek near Brightwood, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	25	32	85	35	52	34	58	130	220	132	34	21
2	25	41	80	76	63	33	61	130	162	140	33	21
3	25	46	105	74	77	32	54	130	142	140	33	20
4	25	91	98	112	70	49	67	120	132	130	31	20
5	25	64	83	190	74	71	144	134	144	118	30	20
6	25	61	67	136	74	46	120	250	193	110	30	19
7	25	60	58	114	70	43	236	340	235	102	30	19
8	24	59	54	87	66	40	205	300	265	100	29	21
9	24	140	51	76	61	38	142	300	265	96	30	22
10	23	140	47	66	59	36	128	250	178	90	28	22
11	23	88	45	59	74	36	144	265	146	85	28	25
12	23	67	63	52	100	35	116	282	128	80	28	23
13	23	54	98	49	90	35	102	235	162	79	28	23
14	23	50	76	45	74	35	93	205	205	74	28	25
15	23	46	63	42	70	34	82	170	235	79	27	24
16	23	43	56	40	112	35	71	142	220	74	27	[a] 22
17	22	40	52	39	93	35	64	134	220	70	27	19
18	22	40	54	37	77	36	60	136	205	66	26	[a] 19
19	22	37	61	36	66	36	60	144	196	61	26	19
20	22	36	73	36	59	36	85	140	187	54	[a] 26	19
21	21	36	54	36	58	36	110	144	202	50	[a] 26	[a] 20
22	21	35	46	34	49	36	108	134	168	46	26	[a] 20
23	21	35	42	34	45	37	170	126	144	45	25	23
24	21	34	38	34	43	50	172	130	175	42	24	[a] 22
25	21	104	37	46	40	41	300	132	150	40	23	22
26	21	124	35	47	39	38	300	132	148	43	23	[a] 22
27	24	269	36	67	36	84	220	162	144	40	23	[a] 21
28	22	150	35	77	35	108	196	220	142	38	22	[a] 20
29	28	107	35	63	.....	140	168	235	130	36	22	20
30	29	102	34	58	.....	88	142	220	124	34	22	19
31	43	.....	34	58	.....	66	.....	235	.....	36	21	.....

[a] Discharge interpolated.

NOTE.—Discharge estimated from comparison with record of Little Sandy River Jan. 28 to Feb. 4 and June 14-18.

Digitized by Google

Monthly discharge of Lost Creek near Brightwood, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 11.2 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	43	21	24.0	2.14	2.47	1,480
November	269	32	74.4	6.64	7.41	4,430
December	105	34	57.9	5.17	5.96	3,560
January	190	34	63 1	5.63	6.49	3,880
February	112	35	65.2	5.82	6.06	3,620
March	140	32	48.4	4.32	4.98	2,980
April	300	54	133	11.9	13.28	7,910
May	340	120	187	16.7	19.25	11,500
June	265	124	179	16.0	17.85	10,700
July	140	34	75.2	6.71	7.74	4,620
August	34	21	27.0	2.41	2.78	1,660
September	25	19	21.1	1.88	2.10	1,260
The year	340	19	79.4	7.09	96.37	57,600

SANDY RIVER CANAL NEAR MARMOT, OREG.

LOCATION.—In NE. ¼ sec. 13, T. 2 S., R. 5 E., about 500 feet below head gate, 1 mile southwest of Marmot, and 9 miles east of Bull Run, Clackamas County.

RECORDS AVAILABLE.—December 22, 1915, to September 30, 1917.

GAGE.—Vertical staff in stilling well; datum even with bottom of canal. Curley simplex gage used July 24 to November 7, 1916. Observer, O. G. Olson.

DISCHARGE MEASUREMENTS.—Made from a footbridge near gage or by wading.

CHANNEL AND CONTROL.—Concrete-lined canal, 13 feet wide on bottom, side slopes 1 to 1. Control is at intake of first tunnel about 200 yards below gage, where there is a drop in grade.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and during period 1916–17, 4.40 feet at 4.30 p. m. August 13 and 7.30 a. m. August 14 (discharge, 504 second-feet); minimum stage recorded, 0.10 foot September 11 to 15, 1916, and August 15 to 22, 1917 (discharge, 1 second-foot—leakage through gates).

ICE.—Stage-discharge relation never affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined. Gage read to half-tenths twice daily. Operation of recorder satisfactory. Daily discharge ascertained by applying to the rating table the mean daily gage height obtained by inspecting the recorder graphs up to November 7, and the mean of two daily readings thereafter, except for days when there was a considerable change in stage, for which the discharge given is the result of averaging the applied gage heights. Records excellent.

Sandy River canal diverts water from Sandy River in the NE. ¼ sec. 13, T. 2 S., R. 5 E., into a reservoir near Bull Run post office, from which it is drawn for the Bull Run hydroelectric plant of the Portland Railway Light & Power Co. The tailrace of the power plant discharges into Bull Run River in the NE. ¼ sec. 6, T. 2 S., R. 5 E.

Discharge measurements o Sandy River canal near Marmot, Oreg., during the year ending Sept. 30 1917.

[Made by F. F. Henshaw.

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Oct. 16	3.52	351
Aug. 7	3.90	411

Digitized by Google

Daily discharge, in second-feet, of Sandy River canal near Marmot, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	388	244	155	268	236	316	236	177	13	180	370	372
2	380	244	152	284	236	316	236	177	12	222	400	194
3	364	244	215	300	244	316	236	174	12	222	432	273
4	364	236	215	300	252	316	236	174	11	222	432	414
5	356	208	208	316	252	316	208	252	11	222	423	414
6	356	201	208	308	252	316	166	252	12	222	423	432
7	348	201	244	308	252	316	172	47	12	284	423	432
8	348	194	260	300	244	324	172	94	25	348	423	468
9	340	150	284	300	244	324	15	96	52	348	423	450
10	332	114	284	292	236	324	16	97	43	348	423	450
11	332	152	284	292	244	324	40	104	42	122	423	450
12	340	208	284	284	252	324	37	102	41	348	423	432
13	340	208	300	284	244	324	80	99	89	438	468	432
14	340	244	300	284	244	316	18	99	166	348	252	450
15	348	284	292	284	244	316	105	97	166	348	1	441
16	356	284	135	284	252	316	145	177	166	348	1	432
17	356	284	284	276	244	316	166	284	166	340	1	338
18	348	300	284	276	244	316	179	284	166	340	1	396
19	332	316	284	276	244	324	177	284	166	332	1	396
20	332	316	292	276	244	324	180	284	166	332	1	396
21	332	308	292	276	236	324	180	115	166	332	1	372
22	324	308	292	276	236	324	179	13	166	332	1	432
23	324	316	292	276	236	324	187	13	166	332	131	432
24	316	308	284	276	244	300	194	10	166	324	348	432
25	316	244	284	284	252	308	215	10	134	324	348	423
26	316	174	284	292	292	177	116	10	104	324	432	432
27	356	91	276	229	192	236	112	10	104	324	414	333
28	364	28	276	172	316	244	128	11	48	324	414	423
29	380	24	276	170	.....	260	146	13	128	316	414	423
30	324	165	268	201	.....	244	160	13	152	372	414	423
31	292	.....	268	236	.....	236	.....	13	.....	310	432	.....

Monthly discharge of Sandy River canal near Marmot, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	388	292	343	21,100
November	316	24	220	13,100
December	300	135	260	16,000
January	316	170	274	16,800
February	316	192	247	13,700
March	324	177	302	18,600
April	236	15	148	8,810
May	284	10	116	7,130
June	166	11	95.7	5,690
July	348	122	304	18,700
August	468	1	293	18,000
September	468	194	406	24,200
The year	468	1	251	182,000

BULL RUN RIVER NEAR BULL RUN, OREG.

LOCATION.—In sec. 25, T. 1 S., R. 5 E., 1¼ miles above intake of Portland water-supply pipe line and 5 miles east of Bull Run, Clackamas County.

DRAINAGE AREA.—102 square miles.

RECORDS AVAILABLE.—August 20, 1907, to September 30, 1917; also readings on a gage belonging to city water department, January 5, 1895, to November 13, 1906.

GAGE.—Friez water-stage recorder referred to vertical staff on left bank. Gage datum raised 2 feet July 26, 1916. Prior to July 28, 1909, an inclined staff at headworks 1¼ miles below present gage. Observer, W. B. Wilson.

Digitized by Google

DISCHARGE MEASUREMENTS.—Made from cable at gage or by wading near gage.

CHANNEL AND CONTROL.—Rocks and gravel; shifting in extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.40 feet at 11 a. m., November 27 (discharge, 7,970 second-feet); minimum stage recorded, 0.67 foot October 25 and 26 (discharge, 87 second-feet).

1895–1917: Maximum stage recorded, 10.6 feet on gage at headworks November 13, 1906 (discharge, 15,400 second-feet); minimum stage recorded, 2.54 feet August 29 to September 4, 1914 (discharge, 72 second-feet), and 2.60 feet September 3–4, 1910 (discharge, 72 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None above station. The two water-supply pipes divert practically all the low-water flow 1¼ miles below the station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed November 4, when flood carried away a large log on control. Rating curve used October 1 to November 3 well defined between 100 and 4,000 second-feet; curve used November 4 to September 30 well defined. Operation of water-stage recorder satisfactory except for short periods. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting gage-height graph or, for days of considerable fluctuation, by averaging results obtained by applying to rating table the mean gage heights for bi-hourly periods. Records excellent.

Discharge measurements of Bull Run River near Bull Run, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 27	Batchelder and Briggs	3.82	2,360
Aug. 7	F. F. Henshaw	.96	175

Daily discharge, in second-feet, of Bull Run River near Bull Run, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	132	280	1,140	320	476	261	916	1,140	1,580	964	192	114
2	129	342	1,010	1,500	665	250	1,020	1,050	1,480	980	189	114
3	126	600	1,390	1,530	1,320	246	886	948	1,340	924	186	114
4	122	1,580	1,260	2,960	1,260	474	1,100	886	1,180	837	183	114
5	119	879	1,140	4,400	1,220	924	2,290	872	1,140	774	174	111
6	116	1,100	865	2,750	1,140	642	1,740	1,720	1,300	732	169	111
7	113	1,180	672	2,310	1,000	576	2,680	2,550	1,480	666	166	118
8	111	996	642	1,420	924	521	2,680	1,910	1,630	624	161	142
9	108	2,290	648	1,220	844	471	1,790	1,910	2,160	600	161	125
10	106	1,850	559	1,060	767	440	1,480	1,530	1,850	554	155	130
11	106	940	498	900	1,090	410	1,850	1,440	1,790	526	155	172
12	106	850	865	760	1,530	386	1,440	1,580	1,480	504	153	132
13	106	761	1,480	660	1,150	382	1,180	1,440	1,580	476	150	128
14	104	672	1,060	582	900	350	1,100	1,300	1,850	471	148	158
15	103	583	830	498	774	329	940	1,140	2,030	466	142	155
16	102	494	690	440	1,100	312	816	1,020	2,030	440	142	130
17	100	405	594	396	932	304	718	1,000	1,740	410	140	118
18	98	316	636	372	774	308	654	1,100	1,530	377	140	114
19	96	288	886	354	672	346	711	1,140	1,480	350	140	109
20	95	250	1,340	337	582	363	1,180	1,140	1,340	324	138	109
21	94	232	1,480	333	515	354	1,480	1,100	1,390	308	135	107
22	92	238	1,140	350	460	350	1,180	980	1,180	288	130	116
23	92	272	851	396	410	456	1,740	908	1,040	269	125	135
24	90	235	672	405	386	951	1,630	948	1,390	253	125	128
25	87	1,800	559	830	354	725	2,420	1,060	1,220	235	125	148
26	87	2,100	476	816	333	588	2,160	1,060	1,100	224	125	135
27	103	4,720	410	1,650	391	1,440	1,630	1,140	1,040	218	123	140
28	118	2,400	363	1,240	284	1,790	1,440	1,390	1,050	238	120	158
29	145	1,440	320	851	.....	2,290	1,260	1,530	1,100	221	120	145
30	242	1,440	320	654	.....	1,390	1,180	1,440	980	207	118	131
31	542	.....	308	548	.....	1,050	.....	1,480	.....	201	116	.....

NOTE.—Discharge interpolated because of defective gage-height record, Oct. 2–6, 15–20, 27, Nov. 12–27, estimated Nov. 10–11.

Digitized by Google

Monthly discharge of Bull Run River near Bull Run, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 102 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	542	87	125	1.23	1.42	7,690
November	4,720	232	1,050	10.3	11.49	62,500
December	1,480	308	810	7.94	9.15	49,800
January	4,400	320	1,060	10.4	11.99	65,200
February	1,530	284	795	7.79	8.11	44,200
March	2,290	246	635	6.23	7.18	39,000
April	2,680	654	1,440	14.1	15.73	85,700
May	2,550	872	1,290	12.6	14.53	79,300
June	2,160	980	1,450	14.2	15.84	86,300
July	980	201	473	4.64	5.35	29,100
August	192	116	147	1.44	1.66	9,040
September	172	107	129	1.26	1.41	7,680
The year	4,720	87	781	7.66	103.86	566,000

LITTLE SANDY RIVER NEAR MARMOT, OREG.

LOCATION.—In SW. ¼ sec. 6, T. 2 S., R. 6 E., at trail bridge at Little Sandy ranger station, 1½ miles north of Marmot, Clackamas County.

DRAINAGE AREA.—17.2 square miles (measured on topographic map).

RECORDS AVAILABLE.—August 14, 1913, to September 30, 1917.

GAGE.—Stevens water-stage recorder referred to vertical staff on left bank just below bridge; inspected by Carl Aschoff.

DISCHARGE MEASUREMENTS.—Made from trail bridge or by wading.

CHANNEL AND CONTROL.—Gravel and boulders; may shift somewhat.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.60 feet at 11 a. m. November 27 (discharge, 1,030 second-feet); minimum stage recorded, 0.25 foot October 25 and 26 (discharge, 14 second-feet).

1913–1917: Maximum stage recorded, 4.55 feet at 4 p. m., November 17, 1915 (discharge, 1,510 second-feet); minimum stage recorded, 0.21 foot August 28, 1914 (discharge, 12 second-feet).

ICE.—Stage-discharge relation never affected by ice.

DIVERSIONS.—None above station.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 800 second-feet. Operation of water-stage recorder somewhat unsatisfactory on account of clock stopping occasionally and stoppage of inlet to well during period of low water. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting recorder graph or, for days of considerable fluctation, by averaging results obtained by applying to rating table the mean gage heights for bihourly periods. Records good.

Discharge measurements of Little Sandy River near Marmot, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Dec. 12	C. L. Batchelder	1.65	178
Aug. 6	F. F. Henshaw	.44	24.9
14	do	.36	18.4

Digitized by Google

Daily discharge, in second-feet, of Little Sandy River near Marmot, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	22	40	189	60	101	52	178	212	300	208	24	16
2	22	89	178	307	120	52	189	200	265	194	24	15
3	21	88	200	318	212	51	178	189	265	181	23	15
4	20	265	178	350	200	98	200	178	224	168	23	15
5	20	189	167	540	200	167	390	178	224	155	22	15
6	19	189	135	410	200	125	335	333	265	142	22	15
7	19	212	112	370	189	112	450	540	300	129	21	17
8	18	145	104	237	178	102	430	370	335	116	21	23
9	18	450	105	200	167	93	318	352	430	108	20	19
10	17	265	96	189	200	84	282	282	352	100	20	20
11	17	125	82	156	237	79	318	282	318	92	19	28
12	17	107	230	135	212	72	265	318	265	84	19	21
13	17	91	450	120	189	71	224	265	318	77	18	22
14	17	67	450	101	178	66	200	251	370	69	18	30
15	17	58	200	86	156	61	189	224	390	61	18	30
16	16	49	156	78	262	55	167	200	390	53	18	21
17	16	46	135	72	200	54	145	200	352	47	18	19
18	16	54	138	68	167	54	135	224	318	45	18	18
19	16	50	200	64	145	56	145	251	300	43	18	18
20	15	42	251	61	125	58	212	251	282	41	17	18
21	15	40	265	61	107	55	282	237	300	39	17	17
22	15	40	224	67	96	56	237	224	251	37	17	18
23	15	54	178	73	84	73	300	200	224	35	17	27
24	15	44	145	76	78	112	300	212	300	33	16	24
25	14	319	116	218	72	107	410	224	287	31	16	34
26	14	370	97	212	68	101	390	224	274	29	16	28
27	20	651	86	251	61	209	360	237	261	27	16	31
28	21	335	76	237	56	335	251	265	248	28	16	37
29	32	237	68	178	.....	390	224	300	235	29	16	28
30	41	237	63	135	.....	265	212	282	222	26	15	24
31	92	.....	58	111	.....	200	.....	282	.....	24	16	.....

NOTE.—Discharge estimated from hydrographic comparison with station on Bull Run River Nov. 4-14 and with station on Lost Creek Feb. 8-13. Discharge interpolated June 25 to July 7, July 9-15, 18-26, and Aug. 2-13.

Monthly discharge of Little Sandy River near Marmot, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 17.2 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	92	14	21.0	1.22	1.41	1,290
November	651	40	165	9.59	10.70	9,820
December	450	58	166	9.65	11.12	10,200
January	540	60	179	10.4	11.99	11,000
February	262	56	152	8.84	9.20	8,440
March	390	51	112	6.51	7.50	6,890
April	450	135	262	15.2	16.96	15,600
May	540	178	258	15.0	17.29	15,900
June	430	222	296	17.2	19.19	17,600
July	208	24	79.1	4.60	5.30	4,860
August	24	15	18.7	1.09	1.26	1,150
September	37	15	22.1	1.28	1.43	1,320
The year	651	14	144	8.37	113.35	104,000

99664°—20—WSP 464——7

Digitized by Google

WILLAMETTE RIVER BASIN.

MIDDLE FORK OF WILLAMETTE RIVER AT JASPER, OREG.

LOCATION.—In NW. ¼ sec. 23, T. 18 S., R. 2 W., just below Jasper post office, Lane County, 2 miles above Natron and 3 miles below Fall Creek.

DRAINAGE AREA.—1,450 square miles.

RECORDS AVAILABLE.—September 16, 1905, to February 6, 1912; July 26, 1913, to March 31, 1917, when station was discontinued.

GAGE.—Vertical staff on right bank; read by B. F. Sylvester.

DISCHARGE MEASUREMENTS.—Made from new highway bridge a short distance above the gage.

CHANNEL AND CONTROL.—Gravel and small boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.45 feet at 7 a. m., March 28 (discharge, 15,600 second-feet); minimum stage recorded, 3.25 feet, October 19 to 27 (discharge, 850 second-feet).

1905–1912 and 1913–1917: Maximum stage recorded, 16.6 feet at 9 a. m., November 23, 1909 (discharge, estimated from extension of rating curve, 122,000 second-feet); minimum authentic discharge, 610 second-feet in September and October, 1915; a minimum of 530 second-feet September to November, 1907, is uncertain.

DIVERSIONS.—None.

REGULATION.—Some storage developed on Waldo Lake, but no storage operations since 1909.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 700 and 10,000 second-feet. Gage read daily to quarter-tenths. Daily discharge ascertained by applying daily gage height to rating table. Records excellent.

The following discharge measurement was made by C. L. Batchelder:

June 12, 1917: Gage height, 5.79 feet; discharge, 6,550 second-feet.

Daily discharge, in second-feet, of Middle Fork of Willamette River at Jasper, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	950	1,280	3,860	2,280	3,320	2,860	16	900	1,220	2,660	2,460	4,760	2,860
2	950	1,060	3,320	3,860	2,860	2,860	17	900	1,220	2,660	2,460	6,200	2,860
3	1,000	1,940	2,860	9,550	6,600	2,860	18	900	1,220	1,780	2,370	5,460	2,860
4	1,000	1,860	5,820	6,600	5,820	2,860	19	850	1,480	4,440	2,280	4,760	2,860
5	1,000	1,940	5,820	9,550	5,820	7,500	20	850	1,410	7,500	2,190	4,440	3,320
6	950	2,020	5,820	14,100	6,200	7,050	21	850	1,340	8,500	2,280	3,860	4,140
7	950	4,440	4,440	10,100	6,200	5,820	22	850	1,280	7,500	2,190	3,860	3,860
8	950	1,780	3,860	7,500	5,820	5,820	23	850	1,280	5,820	2,280	3,320	3,860
9	900	2,020	4,440	5,820	5,100	5,100	24	850	1,220	4,760	2,280	3,320	9,000
10	900	2,020	4,440	5,100	5,100	4,440	25	850	1,410	3,860	2,190	3,860	15,300
11	900	1,860	3,580	4,440	5,820	3,860	26	850	10,100	3,320	2,190	3,580	9,000
12	900	1,620	3,080	4,140	7,500	3,580	27	850	6,200	2,860	2,280	3,320	10,100
13	900	1,410	2,860	3,860	6,600	3,580	28	900	12,900	2,660	5,820	3,080	15,300
14	900	1,340	2,860	3,320	5,820	3,320	29	900	7,500	2,460	3,860	.....	15,300
15	900	1,280	2,860	2,860	4,760	3,080	30	1,280	5,100	1,480	4,440	.....	12,300
							31	1,110	.....	3,320	3,580	.....	9,000

Monthly discharge of Middle Fork of Willamette River at Jasper, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,280	850	922	56,700
November	12,900	1,060	2,760	164,000
December	8,500	1,480	4,050	249,000
January	14,100	2,190	4,460	274,000
February	7,500	2,860	4,900	272,000
March	15,300	2,860	6,020	370,000
The period	.....	.....	.....	1,390,000

Digitized by Google

WILLAMETTE RIVER AT ALBANY, OREG.

LOCATION.—In SW. ¼ sec. 6, T. 11 S., R. 3 W., at the end of Broadalbin Street, Albany, Linn County, about half a mile above Southern Pacific Railroad bridge (formerly Corvallis & Eastern) just below mouth of Calapooya Creek, and about 9 miles by river above Santiam River.

DRAINAGE AREA.—4,860 square miles.

RECORDS AVAILABLE.—November 24, 1878, to April 30, 1882; January 21, 1892, to September 30, 1917; some fragmentary records 1883 to 1888.

GAGE.—Vertical staff in two sections on right bank.

DISCHARGE MEASUREMENTS.—Made from Southern Pacific bridge, or from highway bridge immediately upstream from gage.

CHANNEL AND CONTROL.—Sand and fine gravel; control practically permanent. Above gage height 17 feet some water flows through a slough several hundred feet to the left of the main channel.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.4 feet at 8 a. m. April 9 (discharge, 45,600 second-feet); minimum stage recorded, 0.9 foot October 26–28 (discharge, 3,220 second-feet).

1878–1882 and 1892–1917: Maximum stage recorded, 32.8 feet January 14, 1881 (discharge, 245,000 second-feet); minimum stage recorded, 0.2 foot September 21 to 27, 1879 (discharge, 1,870 second-feet), but this is somewhat uncertain. Lowest stages recorded in recent years are 0.4 foot October 30 to November 10, 1895 (discharge, 2,220 second-feet), and 0.5 foot August 26 to September 25, 1905, September 5 to 14, and October 13–15, 20–22, 1915 (discharge, 2,400 second-feet). The maximum stage ever known was 36.0 feet December 4, 1861 (discharge, 302,000 second-feet).

ICE.—Stage discharge relation unaffected by ice.

DIVERSIONS.—The Albany power canal has diverted water from South Santiam River near Lebanon and discharged into Willamette River above the gage and measuring section since the early nineties. The following measurements have been made of the quantity diverted:

	Second-feet.
Nov. 9, 1911, at Albany	210
Sept. 21, 1912, at intake	262
Sept. 21, 1912, at Albany	242
July 15, 1913, at intake	247
Aug. 23, 1917, at Albany	195

Determinations of run-off per square mile and depth in inches published in Water-Supply Papers 370, 312, 332, 362, and 394 are in error.

REGULATION.—Practically none.

ACCURACY.—Stage-discharge relation for medium and low stages appears to have changed slightly some time during recent years. A new rating curve well defined, has been drawn for stages below 8 feet; this curve applied since October 1, 1916. Gage read to tenths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records excellent.

COOPERATION.—Gage-height record furnished by the Weather Bureau.

Discharge measurements of Willamette River at Albany, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 14	W. E. Dickinson	1.02	3,480
Aug. 27	F. F. Henshaw	1.20	3,740

Digitized by Google

Daily discharge, in second-feet, of Willamette River at Albany, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3,830	4,500	20,500	10,500	16,900	15,700	30,900	21,100	18,100	13,300	5,710	3,620
2	3,830	4,730	18,100	11,000	14,500	14,200	27,800	21,800	18,400	12,700	5,460	3,620
3	3,620	4,500	15,700	16,000	13,900	13,300	32,600	20,800	18,100	13,300	5,210	3,620
4	3,620	5,710	16,300	24,200	16,900	12,700	32,200	19,600	16,900	13,900	5,210	3,620
5	3,620	7,520	22,400	22,400	18,700	14,500	27,100	18,100	15,400	13,900	4,970	3,420
6	3,620	9,930	26,700	28,600	18,700	23,500	29,000	17,500	14,800	13,300	4,970	3,420
7	3,620	9,110	28,200	36,000	18,700	24,200	33,000	19,600	15,700	13,000	4,970	3,420
8	3,620	13,300	23,800	29,700	18,400	22,100	23,000	25,300	16,900	12,700	4,730	3,420
9	3,620	10,200	20,500	23,800	17,500	21,800	45,600	25,600	17,800	12,200	4,730	3,420
10	3,620	8,570	21,100	20,200	16,300	20,500	43,200	26,000	20,800	11,900	4,730	3,620
11	3,620	8,040	19,600	18,100	15,700	18,700	36,000	27,100	21,100	11,600	4,730	3,620
12	3,620	7,520	16,900	16,900	17,500	16,900	37,300	25,300	19,000	11,000	4,500	3,620
13	3,620	7,000	15,400	16,000	20,200	16,000	42,300	24,900	16,900	10,800	4,500	3,620
14	3,620	6,220	14,200	14,200	19,000	15,700	36,000	25,300	15,400	10,200	4,500	3,620
15	3,420	5,710	13,300	13,000	16,900	15,100	31,300	24,200	15,700	9,930	4,270	3,620
16	3,420	5,210	12,700	11,900	15,700	14,200	27,800	22,400	17,800	9,380	4,270	3,620
17	3,420	5,210	12,200	11,000	15,700	16,000	24,500	21,500	17,800	9,380	4,270	3,620
18	3,420	4,970	11,600	10,200	17,200	14,500	22,100	21,100	20,500	9,110	4,270	3,620
19	3,420	5,210	11,000	9,650	16,000	12,400	19,900	22,400	19,300	8,840	4,270	3,620
20	3,420	5,710	14,500	9,110	16,000	12,400	19,000	21,100	19,300	8,570	4,050	3,620
21	3,420	5,460	19,300	9,110	17,800	12,200	20,200	21,100	18,700	8,570	4,050	3,620
22	3,420	5,210	22,400	9,380	18,400	16,000	25,600	20,500	18,100	8,040	4,050	3,420
23	3,420	5,210	23,100	9,380	19,000	16,900	24,900	19,600	17,500	7,520	4,050	3,420
24	3,420	5,210	21,500	9,380	17,800	20,800	25,300	18,400	16,000	7,260	4,050	3,420
25	3,420	5,460	19,900	9,110	16,600	33,900	26,700	17,200	15,100	6,740	4,050	3,420
26	3,220	7,520	17,500	8,840	16,900	45,100	27,800	16,900	14,500	6,480	4,050	3,420
27	3,220	21,800	15,400	9,110	17,200	36,000	30,900	16,000	14,200	6,480	4,050	3,420
28	3,220	20,500	13,900	11,600	16,600	33,400	28,200	15,400	14,200	6,220	4,050	3,420
29	3,420	29,700	12,700	21,100	.....	40,000	24,900	16,900	14,500	5,960	3,830	3,420
30	3,620	23,800	11,900	21,500	.....	41,400	22,800	18,700	13,900	5,960	3,830	3,420
31	4,270	.....	11,000	19,300	.....	38,700	.....	18,700	.....	5,960	3,620	.....

Monthly discharge of Willamette River at Albany, Oreg., for the year ending Sept. 30, 1917

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	4,270	3,220	3,540	218,000
November	29,700	4,500	8,960	533,000
December	28,200	11,000	17,500	1,080,000
January	36,000	8,840	15,800	972,000
February	20,200	13,900	17,200	955,000
March	45,100	12,200	21,600	1,330,000
April	45,600	19,000	29,600	1,760,000
May	27,100	15,400	21,000	1,290,000
June	21,100	13,900	17,100	1,020,000
July	13,900	5,960	9,810	603,000
August	5,710	3,620	4,450	274,000
September	3,620	3,420	3,530	210,000
The year	45,600	3,220	14,100	10,200,000

SALMON CREEK NEAR OAKRIDGE, OREG.

LOCATION.—In NW. ¼ sec. 13, T. 21 S., R. 3 E., about a mile above Southern Pacific Railroad bridge and 3 miles above Oakridge, Lane County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—February 6, 1913, to March 7, 1916, and October 1, 1916, to September 30, 1917.

GAGE.—Stevens continuous water-stage recorder on right bank about a mile above railroad bridge; used since October 1, 1914. Vertical staff on right bank 500 feet above railroad bridge used February 6 to November 21, 1913. Inclined staff on right bank 200 feet above railroad bridge used November 22, 1913, to September 30, 1914. Observers, Flora Warner and Mrs. J. W. Michael.

DISCHARGE MEASUREMENTS.—Made by wading or from railroad bridge.

CHANNEL AND CONTROL.——Gravel and small boulders; may shift during floods.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.49 feet some time between December 25 and April 11, while clock was stopped (discharge, 1,740 second-feet); minimum stage recorded, 0.65 feet (staff gage reading) October 16 (discharge, 132 second-feet).

1913–1917: Maximum stage recorded, 2.92 feet at 3 p. m. November 25, 1915 (discharge, 2,610 second-feet); minimum stage recorded, 0.23 foot at 8 p. m. October 30, 1915 (discharge, 98 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent; lower part of last rating curve slightly revised on basis of latest measurements. New rating curve used from October 1 well defined between 150 and 1,600 second-feet. Operation of water-stage recorder fairly satisfactory; staff gage read on days for which discharge is given October 1 to November 3. Daily discharge ascertained by applying to the rating table the mean daily gage height determined by inspecting gage-height graph or, for days of considerable fluctuation, by averaging results obtained by applying the mean gage heights for short intervals to the rating table. Records good.

Discharge measurements of Salmon Creek near Oakridge, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
May 13	J. C. Kuhns [a]	[b] 2.38	1,530
June 13	C. L. Batchelder	1.88	858
Sept. 5	do	.79	167

[a] Forest ranger. [b] Gage height taken from recorder sheet.

Daily discharge, in second-feet, of Salmon Creek near Oakridge, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Apr.	May.	June.	July.	Aug.	Sept.
1	210	.....	404	.....	980	1,040	830	322	189
2	.....	.....	440	.....	930	1,040	930	315	189
3	.....	222	470	.....	880	930	980	308	186
4	.....	.....	470	.....	830	830	930	300	186
5	200	.....	440	.....	830	830	930	292	186
6	.....	.....	392	.....	1,050	930	880	284	182
7	.....	.....	368	.....	1,400	1,040	880	277	178
8	196	.....	356	.....	1,320	1,240	830	270	175
9	.....	.....	330	.....	1,400	1,560	830	263	175
10	.....	.....	305	.....	1,400	1,400	780	256	175
11	.....	.....	290	1,170	1,400	1,100	780	249	172
12	200	.....	285	1,170	1,480	930	740	242	172
13	.....	.....	285	980	1,560	880	740	246	175
14	.....	.....	285	930	1,400	1,180	690	242	175
15	.....	.....	280	830	1,240	1,480	690	242	175
16	160	.....	275	780	1,100	1,400	650	238	169
17	.....	.....	300	690	1,040	1,330	650	238	163
18	.....	.....	470	650	1,040	1,260	610	230	160
19	.....	.....	650	610	980	1,190	580	222	154
20	132	.....	610	650	930	1,140	540	218	154
21	.....	175	540	780	930	1,070	470	210	151
22	.....	175	470	780	930	1,000	440	206	154
23	142	172	410	980	880	930	440	200	172
24	.....	304	368	1,100	830	930	410	200	169
25	.....	500	335	1,400	780	930	386	200	169
26	140	690	.....	1,560	780	930	368	196	166
27	.....	780	.....	1,320	780	930	368	196	163
28	.....	610	.....	1,170	880	930	350	192	160
29	.....	500	.....	1,040	1,040	880	343	192	571
30	.....	440	.....	980	1,040	830	336	192	571
31	175	.....	.....	.....	1,040	.....	329	189	.....

NOTE.—Discharge interpolated June 14, 17–22, 24–27, and July 29 to Aug. 11.

Digitized by Google

Monthly discharge of Salmon Creek near Oakridge, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
November 21-30	780	172	435	8,630
December 1-25	650	275	393	19,500
April 11-30	1,560	610	978	38,800
May	1,560	780	1,070	65,800
June	1,560	830	1,070	63,700
July	980	329	636	39,100
August	322	189	240	14,800
September	189	151	170	10,100

McKENZIE RIVER AT McKENZIE BRIDGE, OREG.

LOCATION.—In sec. 14, T. 16 S., R. 6 E., at highway bridge at McKenzie Bridge, Lane County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 8, 1910, to September 30, 1916; April 1 to September 30, 1917.

GAGE.—Vertical staff attached to right abutment of the highway bridge at McKenzie Bridge. Gage reader, S. L. Taylor. Another gage, which was formerly read, is located at Hayes ranch, one-half mile above McKenzie Bridge; and a third is on left bank at Paradise ranger station about 2 miles above the bridge.

DISCHARGE MEASUREMENTS.—Made from cable three-eighths mile above the ranger station.

CHANNEL AND CONTROL.—Rocky; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.2 feet June 16 and 19 discharge, 3,450 second-feet); minimum stage recorded, 2.4 feet September 25 and 26 (discharge, 1,420 second-feet).

1910–1917: Maximum stage recorded, 5 feet on gage at highway bridge, January 13, 1912 (discharge, 7,400 second-feet); minimum stage recorded, 1.42 feet November 7, 1915 (discharge, 924 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Daily discharge ascertained by applying daily gage height to rating table. Records good.

COOPERATION.—Gage-height records furnished by U. S. Forest Service, C. R. Seitz, supervisor.

No discharge measurements made during year.

Digitized by Google

Daily discharge, in second-feet, of McKenzie River at McKenzie Bridge, Oreg., for the year ending Sept. 30, 1917.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,670	2,160	2,620	2,620	1,850	1,580	16	1,940	2,500	3,450	2,380	1,670	a1,500
2	1,670	2,050	2,620	2,750	1,760	1,580	17	1,850	2,620	a3,380	a2,320	1,670	1,500
3	1,670	2,050	2,500	2,750	1,760	a1,580	18	1,760	2,500	3,300	2,270	a1,620	a1,500
4	1,670	a2,050	2,380	2,750	a1,760	1,580	19	1,760	2,380	3,450	a2,220	1,580	a1,500
5	1,850	2,050	2,380	a2,750	a1,760	a1,580	20	1,760	a2,320	3,300	2,160	1,580	1,500
6	1,940	a2,280	2,500	2,750	1,760	1,580	21	1,940	2,270	3,150	2,160	1,580	a1,480
7	2,880	2,500	2,750	2,620	1,760	1,580	22	a2,000	a2,240	3,150	2,160	a1,580	a1,470
8	2,750	2,620	2,750	2,620	1,670	1,580	23	2,050	a2,200	a3,060	2,160	1,580	a1,450
9	2,380	2,880	3,300	2,620	a1,670	1,580	24	2,160	2,160	a2,970	2,050	1,580	a1,440
10	2,160	2,750	3,150	2,500	1,670	1,580	25	2,620	2,160	2,880	2,050	1,580	1,420
11	2,160	2,880	2,750	2,380	a1,670	a1,500	26	2,880	2,160	2,750	a2,020	a1,580	1,420
12	2,270	2,750	2,620	a2,380	1,670	1,500	27	2,380	a2,270	2,750	a2,000	a1,580	.....
13	2,160	a2,820	2,500	a2,380	1,670	a1,500	28	2,270	2,380	2,880	a1,970	1,580	.....
14	2,050	2,880	2,620	2,380	1,670	1,500	29	a2,270	2,500	2,750	1,940	1,580	.....
15	a2,000	2,750	3,010	a2,380	1,670	a1,500	30	2,270	2,500	2,620	1,940	1,670	.....
							31	.....	2,620	.....	a1,900	1,580	.....

a Interpolated.

NOTE.—Discharge estimated 1,400 second-feet Sept. 27–30.

Monthly discharge of McKenzie River at McKenzie Bridge, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
April	2,880	1,670	2,110	126,000
May	2,880	2,050	2,430	149,000
June	3,450	2,380	2,880	171,000
July	2,750	1,900	2,330	143,000
August	1,850	1,580	1,660	102,000
September	1,580	.....	1,500	89,300
The period	.....	.....	.....	780,000

NORTH SANTIAM RIVER AT NIAGARA, OREG.

LOCATION.—In SE. ¼ sec. 29, T. 9 S., R. 4 E., just below Badbanks Creek, half a mile below Niagara, Marion County, and about 15 miles below Breitenbush Creek.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—December 21, 1908, to November 17, 1910; June 7, 1911, to September 30, 1917.

GAGE.—Vertical staff in two sections on right bank, about 200 feet below the mouth of Badbanks Creek. Gage reader, H. D. Bondy.

DISCHARGE MEASUREMENTS.—Made from cable 75 feet above gage. Prior to 1913 made from a boat.

CHANNEL AND CONTROL.—Gravel and boulders. Control is about 50 feet below gage and is composed of huge boulders; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.3 feet at 4 p. m. May 7 (discharge, 8,300 second-feet); minimum stage recorded, 1.6 feet October 25 to 28 (discharge, 650 second-feet).

1908–1917: Maximum stage (determined from high-water mark), 16.4 feet about 1 p. m. November 22, 1909 (discharge, 63,200 second-feet); minimum stage, 1.25 feet, September 23 to 25, 1915 (discharge, 430 second-feet).

ICE.—Stage-discharge relation never affected by ice.

DIVERSIONS.—None above station. The Salem power canal diverts water near Stayton.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 400 and 2,000 second-feet and fairly well defined above 2,000 second-feet. Gage read to half-tenths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records good.

Digitized by Google

Discharge measurements of North Santiam River at Niagara, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 12	W. E. Dickinson	1.72	7[illegible]9
Sept. 28	C. L. Batchelder	1.74	747

Daily discharge, in second-feet, of North Santiam River at Niagara, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	800	970	3,360	1,450	1,450	1,350	2,880	4,240	6,240	5,400	1,350	720
2	800	1,350	3,200	1,800	1,560	1,350	2,600	4,240	5,800	5,400	1,250	720
3	800	1,250	5,000	2,320	2,320	1,350	2,460	4,240	5,800	5,200	1,250	760
4	760	3,200	4,060	3,700	2,040	1,450	2,320	4,240	5,400	4,600	1,200	840
5	720	2,320	3,520	6,240	2,040	1,920	2,740	4,240	5,400	4,420	1,200	880
6	720	2,180	2,880	5,000	2,180	1,800	3,880	6,240	5,400	4,060	1,150	1,680
7	685	1,920	2,460	3,360	2,180	1,680	7,120	8,060	5,800	3,880	1,150	1,800
8	720	1,800	2,320	2,880	2,040	1,560	6,680	8,060	6,460	3,700	1,100	1,800
9	685	2,040	2,180	2,460	2,180	1,450	5,400	8,060	8,060	3,520	1,100	1,800
10	685	1,920	2,040	2,320	2,180	1,350	5,800	7,580	7,580	3,200	1,060	1,800
11	720	1,800	1,920	2,180	2,600	1,350	5,200	7,120	7,340	2,880	1,060	1,800
12	720	1,560	1,800	2,040	3,200	1,350	5,000	6,900	7,580	2,740	1,060	1,800
13	720	1,350	2,040	1,920	3,040	1,350	4,240	6,680	7,580	2,600	1,060	2,040
14	720	1,350	2,040	1,800	2,600	1,350	3,880	6,240	7,580	2,600	1,060	1,920
15	720	1,200	1,920	1,680	2,460	1,250	3,520	6,020	7,580	2,600	1,060	1,920
16	720	1,150	1,800	1,560	3,880	1,250	3,200	5,400	7,580	2,460	1,020	1,920
17	685	1,150	1,800	1,450	3,200	1,200	2,740	5,000	7,580	2,460	1,020	1,680
18	685	1,250	1,800	1,450	2,880	1,150	2,600	4,600	7,580	2,320	1,020	1,560
19	685	1,150	2,320	1,350	2,600	1,560	2,600	4,600	7,340	2,320	970	1,350
20	685	1,150	2,460	1,450	2,320	1,350	3,040	4,420	7,120	2,320	970	1,100
21	685	1,150	2,320	1,350	2,180	1,250	3,360	4,420	6,900	2,180	925	925
22	685	1,100	2,180	1,350	2,040	1,350	3,360	4,420	7,120	2,180	880	840
23	685	1,250	2,040	1,350	1,920	1,800	3,200	4,600	7,120	2,040	840	880
24	685	1,250	2,040	1,350	1,800	2,180	3,520	4,600	7,120	1,920	840	970
25	650	4,800	2,040	1,250	1,680	1,920	4,060	4,600	7,120	1,800	800	970
26	650	4,600	1,680	1,350	1,800	2,460	4,600	4,600	6,680	1,680	800	925
27	650	6,680	1,560	1,350	1,680	2,740	5,000	4,600	6,460	1,560	800	925
28	650	5,400	1,450	1,350	1,450	3,200	5,400	4,800	6,240	1,450	800	760
29	760	3,520	1,350	1,350	.....	5,000	5,000	5,000	5,800	1,350	760	720
30	1,060	3,700	1,350	1,350	.....	4,240	4,600	5,400	5,600	1,350	760	720
31	970	.....	1,250	1,450	.....	2,880	.....	6,240	.....	1,350	760	.....

Monthly discharge of North Santiam River at Niagara, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,060	650	728	44,800
November	6,680	970	2,180	130,000
December	5,000	1,250	2,260	139,000
January	6,240	1,250	2,040	125,000
February	3,880	1,450	2,270	126,000
March	5,000	1,150	1,850	114,000
April	7,120	2,320	4,000	238,000
May	8,060	4,240	5,470	336,000
June	8,060	5,400	6,770	403,000
July	5,400	1,350	2,820	173,000
August	1,350	760	1,000	61,500
September	2,040	720	1,280	76,200
The year	8,060	650	2,720	1,970,000

Digitized by Google

CLACKAMAS RIVER NEAR CAZADERO, OREG.

LOCATION.—In NE. ¼ sec. 11, T. 4 S., R. 4 E., a short distance above backwater from Cazadero dam of Portland Railway, Light & Power Co. and 3 miles southeast of Cazadero, Clackamas County.

DRAINAGE AREA.—685 square miles.

RECORDS AVAILABLE.—January 1, 1909, to September 30, 1917.

GAGE.—Friez water-stage recorder referred to a vertical staff on right bank; inspected by employee of Portland Railway, Light & Power Co.

DISCHARGE MEASUREMENTS.—Made from a cable 50 feet below gage.

CHANNEL AND CONTROL.—Rocks and gravel; shifting in extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 31.77 feet at 6 a. m. June 9 (discharge, 8,170 second-feet); minimum discharge occurred October 22 to 26 and is estimated at 950 second-feet; water-stage recorder not working satisfactorily.

1909–1917: Maximum stage recorded, 43.7 feet at 1 p. m. November 22, 1909 (discharge, 46,800 second-feet); minimum stage recorded, 25.7 feet September 21 to 23 and October 8 to 10, 1915 (discharge, 705 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during high water of June 9. Curve used October 1 to June 8 well defined; that used June 9 to September 30 fairly well defined. Operation of water-stage recorder satisfactory, except for several short periods. Daily discharge ascertained by applying to rating table the mean daily gage height determined from recorder graph by inspection. Records good except for periods of defective gage-height record, for which they are fair.

No discharge measurements made during year.

Daily discharge, in second-feet, of Clackamas River near Cazadero, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,000	1,450	3,310	1,600	1,850	1,650	3,120	4,350	6,470	4,480	1,550	1,090
2	1,000	1,270	3,120	2,130	1,900	1,600	3,310	4,090	6,190	4,740	1,520	1,090
3	1,000	2,070	3,960	2,920	2,370	1,550	3,050	4,090	5,650	4,740	1,480	1,090
4	1,000	3,570	4,350	2,860	2,670	1,800	2,980	3,830	5,260	4,610	1,450	1,090
5	1,000	2,550	3,830	5,390	2,790	2,550	4,220	3,830	5,260	4,350	1,420	1,090
6	1,000	2,390	3,180	5,000	2,920	2,190	4,350	6,000	5,520	4,090	1,400	1,090
7	1,000	2,230	2,610	3,960	2,920	1,960	5,390	8,000	6,190	3,830	1,380	1,090
8	995	2,070	2,490	3,310	2,860	1,960	6,470	8,000	6,750	3,570	1,360	1,110
9	990	2,500	2,430	2,980	2,730	1,960	5,390	8,000	8,060	3,570	1,340	1,130
10	985	2,300	2,250	2,790	2,670	1,850	4,610	7,500	7,450	3,440	1,320	1,130
11	980	2,100	2,070	2,610	2,920	1,790	5,260	7,000	6,750	3,310	1,300	1,240
12	975	1,900	2,430	2,400	3,440	1,730	4,870	6,750	5,910	3,180	1,290	1,130
13	970	1,700	3,310	2,190	3,440	1,670	4,350	6,470	5,650	2,990	1,290	1,180
14	964	1,550	2,980	2,070	3,050	1,620	4,090	6,330	6,330	2,320	1,290	1,180
15	964	1,450	2,610	1,960	2,790	1,570	3,700	6,050	7,310	2,810	1,240	1,170
16	960	1,400	2,370	1,850	3,700	1,510	3,570	5,390	7,750	2,700	1,240	1,090
17	960	1,360	2,190	1,800	3,830	1,450	3,240	5,130	7,450	2,590	1,240	1,070
18	960	1,360	2,250	1,750	3,310	1,500	2,980	5,000	6,890	2,480	1,200	1,050
19	960	1,360	2,670	1,750	2,980	1,500	2,860	4,870	6,750	2,320	1,200	1,050
20	960	1,360	3,120	1,700	2,790	1,500	3,180	5,000	6,470	2,200	1,200	1,040
21	955	1,360	3,310	1,700	2,550	1,500	3,960	5,130	6,470	2,100	1,190	1,030
22	950	1,360	3,050	1,600	2,370	1,500	3,830	5,000	6,050	2,040	1,180	1,040
23	950	1,320	2,610	1,600	2,130	1,650	4,350	4,870	5,390	1,940	1,160	1,090
24	950	1,320	2,310	1,600	2,070	3,050	5,000	4,610	5,390	1,840	1,160	1,090
25	950	2,980	2,020	1,700	2,020	2,670	5,780	4,610	5,130	1,790	1,130	1,110
26	950	4,350	1,960	1,850	1,900	2,190	6,330	4,350	5,000	1,740	1,130	1,090
27	1,020	5,650	1,850	2,860	1,800	3,050	5,910	4,740	5,000	1,700	1,120	1,080
28	1,090	5,520	1,750	3,310	1,700	4,090	5,520	5,650	5,130	1,650	1,110	1,090
29	1,000	3,960	1,650	2,550	.....	5,780	5,130	6,330	4,870	1,650	1,110	1,050
30	1,650	3,830	1,600	2,130	.....	4,480	4,610	6,190	4,610	1,620	1,110	1,030
31	2,020	.....	1,600	1,960	.....	3,570	.....	6,190	.....	1,590	1,090	.....

NOTE.—No gage-height record, discharge estimated by comparison with records on Bull Run and North Santiam rivers Oct. 22–27, Nov. 9–11, Mar. 18–22, and May 6–11; interpolated Oct. 2–6, 8–13, 16–20, Nov. 6–7, Jan. 12, Mar. 11–16, July 30 to Aug. 4, and Aug. 6–11.

Digitized by Google

Monthly discharge of Clackamas River near Cazadero, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 685 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	2,020	950	1,040	1.52	1.75	64,000
November	5,650	1,270	2,320	3.39	3.78	138,000
December	4,350	1,600	2,620	3.82	4.40	161,000
January	5,390	1,600	2,450	3.58	4.13	151,000
February	3,830	1,700	2,660	3.88	4.04	148,000
March	5,780	1,450	2,210	3.23	3.72	136,000
April	6,470	2,860	4,380	6.39	7.13	261,000
May	8,000	3,830	5,590	8.16	9.41	344,000
June	8,060	4,610	6,100	8.91	9.94	364,000
July	4,740	1,590	2,840	4.15	4.78	175,000
August	1,550	1,090	1,260	1.84	2.12	77,500
September	1,240	1,030	1,100	1.61	1.80	65,500
The year	8,060	950	2,880	4.20	57.00	2,080,000

OAK GROVE FORK OF CLACKAMAS RIVER AT INTAKE NEAR CAZADERO, OREG.

LOCATION.—In SW. ¼ sec. 4, T. 6 S., R. 7 E., 2,000 feet above proposed intake of Oak Grove power development of Portland Railway, Light & Power Co., about 35 miles above Cazadero, Clackamas County.

DRAINAGE AREA.—131 square miles (measured by Portland Railway, Light & Power Co.).

RECORDS AVAILABLE.—May 21, 1909, to August 4, 1917.

GAGE.—Stevens water-gage recorder on left bank, used since December, 1916; Watson recording gage used March, 1912, to September, 1913; Friez recorder October, 1913, to October, 1916.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Gravel; fairly permanent. Velocities high. Channel straight.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 2.55 feet June 15 (discharge, 1,650 second-feet); minimum stage for year probably occurred September 30 and was approximately the same as that recorded at time of measurement, 0.80 foot October 5, 1917 (discharge, 395 second-feet).

1909–1917: Maximum stage recorded, 3.40 feet November 24, 1909 (discharge, 2,670 second-feet); minimum discharge, 320 second-feet (gage height, 0.60 foot) October 17 to November 3, 1911.

ICE.—Never any ice, as stream is largely spring-fed.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent during year. Rating curve well defined. Operation of water-stage recorder satisfactory December 15 to April 29, June 3 to July 17, and for short periods at other times. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting the recorder graph. Records good except those for periods for which they are estimated, which are fair.

COOPERATION.—Field data furnished by Portland Railway, Light & Power Co.

The following discharge measurement was made by Frank Ewing:

April 5, 1917: Gage height, 1.00 foot; discharge, 472 second-feet.

Digitized by Google

Daily discharge, in second-feet, of Oak Grove Fork of Clackamas River at intake near Cazadero, Oreg., for the year ending Sept. 30, 1917.

Day.	Dec.	Jan.	Feb.	Mar.	Apr.	June.	July.	Aug.
1	.....	462	453	458	540	1,200	1,020	476
2	.....	480	462	453	520	1,200	940	480
3	.....	490	480	453	500	1,230	900	471
4	.....	500	476	458	490	1,280	900	458
5	.....	580	476	458	530	1,280	865	.....
6	.....	555	476	466	545	1,360	830	.....
7	.....	535	480	471	610	1,410	795	.....
8	.....	520	480	466	640	1,550	748	.....
9	.....	515	480	466	622	1,550	736	.....
10	.....	505	480	458	622	1,410	712	.....
11	.....	495	480	453	640	1,320	700	.....
12	.....	490	490	453	622	1,360	688	.....
13	.....	490	490	448	610	1,410	670	.....
14	.....	480	490	444	610	1,500	622	.....
15	505	471	490	435	586	1,600	610	.....
16	500	471	570	435	575	1,550	598	.....
17	495	471	560	435	560	1,500	580	.....
18	495	471	550	435	555	1,460	573	.....
19	505	466	540	431	550	1,410	566	.....
20	520	466	530	435	586	1,410	559	.....
21	520	466	525	431	610	1,360	552	.....
22	505	462	510	435	610	1,320	544	.....
23	500	458	500	448	676	1,270	536	.....
24	495	453	500	444	712	1,230	528	.....
25	480	476	490	431	795	1,180	521	.....
26	476	476	480	466	830	1,160	514	.....
27	476	525	466	500	830	1,140	507	.....
28	471	495	462	540	830	1,100	500	.....
29	462	485	.....	580	795	1,060	495	.....
30	462	471	.....	560	795	1,060	490	.....
31	458	453	.....	550	.....	.....	480	.....

NOTE.—Discharge estimated Mar. 28 to Apr. 3, Apr. 30, and June 1-3 from the points of maximum and minimum stage indicated on the recorder graph. Discharge interpolated June 22, 23, 26, and July 18-27.

Monthly discharge of Oak Grove Fork of Clackamas River at intake near Cazadero, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum	Mean.	
December 15-31	520	458	490	16,500
January	580	453	488	30,000
February	570	453	495	27,500
March	580	431	464	28,500
April	830	490	633	37,700
May	.....	.....	[a] 1,000	61,500
June	1,600	1,060	1,330	79,100
July	1,020	480	654	40,200

[a] Estimated.

Digitized by Google

LEWIS RIVER BASIN.

LEWIS RIVER NEAR AMBOY, WASH.

LOCATION.—In sec. 36, T. 6 N., R. 3 E., at Cresap's ferry crossing, on county road from Amboy to Cougar, 1½ miles below Canyon Creek, 2 miles above Speilei Creek, and about 5 miles northeast of Amboy, Clarke County.

DRAINAGE AREA.—665 square miles (measured on map in Water-Supply Paper 253, p. 74, and checked on Forest Service map).

RECORDS AVAILABLE.—January 20, 1911, to September 30, 1917.

GAGE.—Inclined staff on left bank, replacing vertical staff at same location and datum; read once daily. Gage reader, James Hanley.

DISCHARGE MEASUREMENTS.—Made from cable at gage.

CHANNEL AND CONTROL.—Gravel and small boulders; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.3 feet November 29 (discharge, 11,100 second-feet); minimum stage recorded, 0.30 foot, October 19 to 24 (discharge, 840 second-feet).

1911–1917: Maximum stage recorded, 12 feet at 12 p. m. December 21, 1915 (discharge, 37,700 second-feet); minimum stage recorded, 0.08 foot, September 30, 1915 (discharge, 686 second-feet).

ICE.—Stage-discharge relation never affected by ice.

DIVERSION.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 900 and 14,000 second-feet. Gage read to hundredths twice daily; oftener during high water. Daily discharge ascertained by applying mean daily gage height to rating table. Records excellent.

No discharge measurements made during year.

Daily discharge, in second-feet, of Lewis River near Amboy, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,070	1,450	4,200	1,910	2,040	2,180	4,000	8,300	9,530	6,620	1,670	1,030
2	1,160	2,470	4,880	2,180	2,320	2,040	4,420	7,710	8,910	6,360	1,670	1,030
3	1,070	2,320	6,360	2,780	2,620	1,910	3,810	6,620	8,000	6,890	1,670	990
4	990	6,620	7,710	4,200	3,280	2,040	4,200	5,600	8,000	6,620	1,670	950
5	990	5,600	5,600	10,200	4,420	2,320	5,360	5,600	7,160	6,360	1,560	950
6	990	4,200	4,420	9,530	3,810	2,620	7,160	8,000	7,430	5,850	1,560	950
7	990	3,280	4,000	5,600	3,450	2,470	8,910	8,000	8,000	5,360	1,450	910
8	990	3,110	3,810	5,120	3,450	2,320	10,500	8,300	7,710	5,120	1,450	910
9	950	5,600	4,420	4,420	3,450	2,180	8,910	10,200	9,530	5,360	1,450	1,160
10	950	4,880	4,200	4,200	3,280	2,180	6,620	9,220	8,600	5,120	1,350	1,200
11	910	3,450	3,630	4,000	4,880	2,040	6,360	9,220	7,430	4,650	1,350	1,200
12	910	3,110	3,110	3,810	5,120	2,040	7,710	9,530	6,100	4,420	1,250	1,200
13	910	2,940	3,110	3,450	4,420	1,910	6,620	9,530	6,620	4,420	1,250	1,250
14	950	2,780	2,780	3,280	4,200	1,910	6,620	8,910	8,600	4,200	1,250	1,250
15	910	2,180	2,780	3,110	4,000	1,910	5,850	8,000	9,530	4,200	1,250	1,200
16	910	1,910	2,620	2,620	3,630	1,790	4,650	7,710	10,200	4,000	1,200	1,160
17	910	1,910	2,470	2,470	3,630	1,790	4,420	6,890	9,840	3,630	1,200	1,160
18	875	2,040	2,470	2,470	3,450	1,790	4,200	6,360	9,530	3,450	1,250	1,160
19	840	1,910	2,470	2,320	3,450	1,910	4,650	6,100	8,600	3,280	1,250	1,160
20	840	1,790	2,780	2,180	3,450	2,040	6,100	6,100	8,300	3,110	1,350	1,070
21	840	1,790	3,450	2,180	3,450	1,910	6,620	5,850	8,000	2,940	1,250	1,030
22	840	1,910	3,110	2,180	3,110	1,910	6,890	5,850	7,710	2,940	1,250	990
23	840	1,910	2,780	2,040	2,780	2,180	7,710	5,600	6,620	2,780	1,250	990
24	840	1,790	2,620	1,910	2,620	2,620	8,000	5,850	6,620	2,470	1,250	1,070
25	910	4,200	2,470	4,200	2,470	2,470	8,300	5,600	6,100	2,320	1,200	1,200
26	990	5,360	2,320	3,810	2,470	2,620	8,300	5,600	6,890	2,180	1,160	1,200
27	990	7,160	2,180	3,630	2,320	4,200	8,000	6,100	7,430	2,040	1,120	1,160
28	990	8,300	2,040	3,450	2,180	5,120	7,710	7,710	6,890	1,910	1,120	1,160
29	1,160	11,100	1,910	2,780	.....	8,910	8,000	8,300	6,890	1,910	1,120	1,120
30	1,160	8,000	1,910	2,470	.....	6,360	8,600	8,600	6,100	1,790	1,070	1,120
31	1,350	.....	1,790	2,180	.....	4,200	.....	9,220	.....	1,790	1,070	.....

Digitized by Google

Monthly discharge of Lewis River near Amboy, Wash., for the year ending Sept. 30, 1917.

[Drainage area, 665 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	1,350	840	969	1.46	1.68	59,600
November	11,100	1,450	3,840	5.77	6.44	228,000
December	7,710	1,790	3,370	5.07	5.84	207,000
January	10,200	1,910	3,570	5.37	6.19	220,000
February	5,120	2,040	3,350	5.04	5.25	186,000
March	8,910	1,790	2,710	4.08	4.70	167,000
April	16,500	3,810	6,640	9.98	11.14	395,000
May	10,200	5,600	7,430	11.2	12.91	457,000
June	10,200	6,100	7,900	11.9	13.28	470,000
July	6,890	1,790	4,000	6.02	6.94	246,000
August	1,670	1,070	1,320	1.98	2.28	81,200
September	1,250	910	1,060	1.59	1.77	63,100
The year	11,100	840	3,840	5.77	78.42	2,780,000

KALAMA RIVER BASIN.

KALAMA RIVER NEAR KALAMA, WASH.

LOCATION.—In sec. 7, T. 6 N., R. 1 E., 150 feet below power house of North Coast Power Co., about 10 miles east of Kalama, Cowlitz County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 6, 1911, to January 11, 1912; December 1, 1912, to September 30, 1913; August 19, 1916, to September 30, 1917.

GAGE.—Vertical staff bolted to rock ledge on left bank; lower section up to 8 feet on left bank; upper section, reading 8 to 12 feet, in a cove on right bank opposite lower section. Gage reader, L. A. Van Fleet. Gage at same site but with datum 2 feet lower, used 1911 to January, 1912, and one with datum 3 feet lower used December, 1912, to September, 1913.

DISCHARGE MEASUREMENTS.—Made from a cable about one-half mile below gage.

CHANNEL AND CONTROL.—Control is a rock reef and bar of heavy gravel about 100 feet below gage; gravel may shift in extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.02 feet at noon January 5, observer noted crest of rise (discharge, 4,430 second-feet); minimum stage recorded, 0.88 foot October 23 to 26 and 28 (discharge, 246 second-feet).

1911–1913 and 1916–1917: Water over gage (top of gage 7.0 feet present datum) January 1 and 3, 1913 (discharge estimated 6,000 second-feet); minimum stage recorded, 0.85 foot (referred to 1916 datum) August 27 to September 1, 1911 (discharge, 232 second-feet).

ICE.—Stage-discharge relation never affected by ice.

DIVERSIONS.—None.

REGULATION.—Operation of power plant causes some fluctuation but gage is read only at times when load is steady.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined above 300 second-feet. Gage read once daily to hundredths. Daily discharge ascertained by applying daily gage height to rating table. Record excellent for discharge above 300 second-feet; good for discharge below 300 second-feet.

Digitized by Google

Discharge measurements of Kalama River near Kalama, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 25	J. L. Stannard [a]	0.88	243	Mar. 29	C. L. Batchelder	4.95	3,120
25	do	0.88	252	30	do	4.40	2,500
Mar. 29	C. L. Batchelder	5.05	3,180				

[a] Hydraulic engineer for North Coast Power Co.

Daily discharge, in second-feet, of Kalama River near Kalama, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	276	360	1,250	700	870	645	1,780	2,040	1,620	1,110	435	292
2	276	645	1,860	1,460	1,050	645	1,950	1,780	1,620	1,050	435	292
3	276	672	2,930	2,040	1,320	595	1,780	1,780	1,460	1,110	435	292
4	276	1,780	3,040	1,860	1,620	930	1,780	1,460	1,320	1,050	415	292
5	276	1,180	2,040	4,400	1,780	1,180	2,410	1,320	1,320	1,050	415	292
6	261	990	1,620	3,390	1,780	990	2,310	1,620	1,320	1,050	415	276
7	261	930	1,320	2,610	1,620	930	3,630	1,950	1,320	1,050	396	276
8	261	870	1,180	2,130	1,780	930	4,140	1,950	1,460	990	396	292
9	261	1,390	1,050	1,860	1,620	810	3,150	2,310	1,620	870	378	292
10	261	1,180	1,050	1,780	1,620	930	2,610	2,040	1,700	700	378	308
11	261	930	1,050	1,620	1,950	870	2,710	1,950	1,390	700	360	342
12	261	755	1,050	1,320	1,950	755	2,610	2,040	1,110	700	360	342
13	261	700	1,180	1,250	1,950	810	2,220	2,040	1,110	700	360	308
14	261	700	1,180	1,110	1,460	755	2,310	1,780	1,460	700	360	342
15	261	522	1,050	1,050	1,320	700	2,040	1,700	1,780	700	342	325
16	246	415	1,050	930	1,460	700	1,780	1,320	1,700	672	342	308
17	246	415	930	870	1,320	645	1,540	1,320	1,460	645	342	292
18	246	545	930	870	1,320	672	1,460	1,320	1,320	620	342	276
19	246	435	1,050	810	1,180	810	1,860	1,250	1,320	595	342	276
20	246	415	1,180	700	1,050	930	2,410	1,250	1,250	570	342	276
21	246	415	1,390	700	1,050	870	2,610	1,320	1,250	570	342	261
22	246	415	1,780	755	930	990	2,130	1,250	1,250	545	325	276
23	246	595	1,460	700	810	1,780	1,950	1,250	1,050	522	325	276
24	246	570	1,320	700	810	2,410	1,780	1,250	1,460	500	308	276
25	246	1,390	1,050	930	810	1,950	1,950	1,320	1,250	500	308	308
26	246	810	990	930	810	1,700	2,130	1,320	1,110	455	308	292
27	246	2,930	870	2,130	810	1,950	2,040	1,320	1,110	455	308	292
28	246	2,310	810	1,390	645	1,950	1,950	1,700	1,320	455	308	292
29	396	1,620	700	1,250	.....	3,270	1,950	1,780	1,620	455	308	276
30	342	1,320	700	930	.....	2,510	2,130	1,860	1,250	455	308	261
31	595	.....	700	930	.....	2,040	.....	1,620	.....	455	292	.....

Monthly discharge of Kalama River near Kalama, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	595	246	275	16,900
November	2,930	360	940	55,900
December	3,040	700	1,280	78,700
January	4,400	700	1,420	87,300
February	1,950	645	1,310	72,800
March	3,270	595	1,210	74,400
April	4,140	1,460	2,240	133,000
May	2,310	1,250	1,620	99,600
June	1,780	1,050	1,380	82,100
July	1,110	455	710	43,700
August	435	292	356	21,900
September	342	261	293	17,400
The year	4,400	246	1,080	784,000

Digitized by Google

COWLITZ RIVER BASIN.

OHANAPECOSH RIVER NEAR LEWIS, WASH.

LOCATION.—In sec. 29, T. 14 N., R. 10 E., 900 feet above Clear Fork and 7 miles northeast of Lewis, in Lewis County.

DRAINAGE AREA.—116 square miles (measured on Plate I, Water-Supply Paper 313).

RECORDS AVAILABLE.—August 19, 1907, to January 12, 1913; April 14, 1913, to September 30, 1917, when station was discontinued.

GAGE.—Inclined staff on left bank, 900 feet above Clear Fork, since May 4, 1915; prior to January 5, 1914, vertical staff 8 feet upstream from site of present gage and at datum 0.06 foot lower; January 13, 1914, to May 1, 1915, vertical staff at site of previous gage and at datum of present gage. Gage read by J. A. Combs.

DISCHARGE MEASUREMENTS.—Made from cable 30 feet below gage or by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and small boulders; apparently permanent. Lodging and washing away of drift below gage at high stages changes stage-discharge relation. One channel at all stages. Banks not subject to overflow. Stage of zero flow, mean of several measurements; gage height 0.5 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.30 feet June 16 (discharge, 3,060 second-feet); minimum stage recorded, 0.28 foot October 28 (discharge, 70 second-feet).

1907–1917: Maximum stage recorded, above top of gage (8 feet) November 23, 1909 (mean discharge for day estimated at 7,500 second-feet); minimum stage recorded, 0.20 foot September 28, 1915 (discharge, 56 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed about July 1, 1917. Rating curve used prior to the change well defined above and fairly well defined below 70 second-feet. Rating curve used after the change well defined above and fairly well defined below 150 second-feet. Gage read to hundredths. Daily discharge ascertained by applying daily gage height to rating table. Records excellent.

COOPERATION.—Gage-height record furnished by Portland Railway, Light & Power Co.

Discharge measurements of Ohanapecosh River near Lewis, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 4	C. O. Brown	0.42	96
May 27	John McCombs	3.14	1,340
Sept. 19	L. D. Carson	.65	166

Digitized by Google

Daily discharge, in second-feet, of Ohanapecosh River near Lewis, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	May.	June.	July.	Aug.	Sept.
1									207
2			188			1,820			
3	104			108	522				
4								635	
5					522		2,540		180
6			192	252					
7	94	158				930			
8								545	175
9			161			2,300			
10	88			322				460	
11		235			1,520		2,380		
12			204						168
13	92			235		1,240			
14								420	
15		149			1,240		2,460		155
16			173			3,060			
17	115			158					
18		113					2,620	380	
19			167		930				168
20	92			137		2,300			
21							1,310		
22		132						270	155
23			158		930	1,660			
24	73			132					
25		115					1,170	270	
26					990				139
27			129	252		1,820			
28	70						820		
29		176						225	
30			115		2,140	2,460			
31	115						680		

COWLITZ RIVER AT LEWIS, WASH.

LOCATION.—In sec. 15, T. 13 N., R. 9 E., at suspension bridge about a mile northeast of Lewis and 1½ miles below Lake Creek, in Lewis County.

DRAINAGE AREA.—275 square miles (measured on Plate I, Water-Supply Paper 313).

RECORDS AVAILABLE.—July 1, 1911, to September 30, 1917.

GAGE.—Vertical staff bolted to solid rock on left bank 40 feet above suspension bridge, installed May 3, 1915; read by William Sethe and J. A. Combs. Original gage was installed August 15, 1907, by Valley Development Co., on left bank 150 feet below site of present gage and at a different datum; this gage was washed out November 20, 1911, and November 3, 1914, but was replaced each time at same site and datum. Datum of published gage heights for year ending September 30, 1913, is 0.07 foot lower than correct datum of old gage, as corrections to gage heights were not applied for that year.

DISCHARGE MEASUREMENTS.—Made from bridge at gage or by wading.

CHANNEL AND CONTROL.—Bed of stream composed of gravel and sand; shifts at high water. Right bank subject to overflow at extremely high stages. Control is gravel and boulder riffle 300 feet below gage. Stage of zero flow, according to measurement made October 5, 1916, gage height -0.45 ± 0.1 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.02 feet at 8.30 p. m. June 16 (discharge, 8,970 second-feet); minimum stage recorded, 0.80 foot October 26 (discharge, 323 second-feet).

1911–1917: Maximum stage recorded, 7.35 feet November 19, 1911 (discharge not determined); stage probably higher on following day, when gage was washed out; minimum stage recorded, 0.95 foot October 30 to November 3, 1911 (discharge, 285 second-feet).

Digitized by Google

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed May 12, May 29, and June 18. Rating curve used October 1 to May 12 and May 29 to June 18 fairly well defined; curve used May 13 to 28 and June 19 to September 30 also fairly well defined. Gage read once daily to hundredths. Daily discharge ascertained by applying daily gage height to rating table. Records good.

COOPERATION.—Gage-height record furnished by United States Forest Service and Portland Railway, Light & Power Co.

Discharge measurements of Cowlitz River at Lewis, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 5	C. O. Brown	0.96	394	May 29	John McCombs	4.52	5,400
May 25	John McCombs	2.78	2,310	Sept. 18	L. D. Carson	1.40	781

Daily discharge, in second-feet, of Cowlitz River at Lewis, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	490	366	575	413	490	518	575	1,330	5,210	5,700	1,760	929
2	463	635	575	438	518	490	575	1,330	4,330	6,620	2,190	929
3	438	546	700	413	668	463	546	1,330	3,500	7,100	2,040	929
4	390	810	668	490	930	518	546	1,220	2,930	7,340	1,900	853
5	390	692	635	770	1,120	518	1,020	1,330	2,580	6,390	1,900	781
6	413	575	575	770	1,120	490	1,020	1,650	2,930	6,390	1,700	781
7	413	490	546	700	1,020	463	1,450	1,970	3,910	5,930	1,510	748
8	390	546	546	700	1,020	463	1,570	2,580	4,670	5,030	1,510	781
9	390	1,570	518	1,020	975	463	1,330	3,500	5,430	6,620	1,460	748
10	390	1,120	490	975	975	463	1,220	3,700	4,330	6,160	1,460	715
11	390	810	463	890	1,150	438	1,330	3,910	3,300	6,160	1,460	817
12	390	635	635	770	1,330	413	1,170	4,120	2,580	5,700	1,400	781
13	366	575	930	735	1,220	413	1,070	3,960	3,300	5,930	1,510	748
14	413	518	832	635	1,120	413	1,020	3,760	4,550	5,470	1,460	748
15	438	518	735	575	1,020	413	930	3,370	6,570	6,390	1,400	748
16	518	490	700	546	1,280	390	890	2,660	8,200	6,390	1,460	782
17	463	463	635	518	1,220	402	810	2,340	7,260	5,700	1,400	817
18	390	463	668	518	1,110	413	770	2,420	8,440	5,930	1,300	781
19	366	438	635	490	1,000	413	770	2,500	7,180	5,030	1,300	781
20	366	413	635	490	890	413	850	2,190	5,930	4,380	1,240	781
21	366	413	635	463	810	413	930	2,190	6,160	3,960	1,200	685
22	355	438	605	463	770	413	930	2,340	5,250	3,370	1,100	655
23	344	438	546	438	700	490	1,020	2,500	4,170	3,000	1,060	655
24	344	413	518	463	635	490	1,120	2,500	6,390	2,500	1,100	547
25	323	575	490	700	605	463	1,970	2,500	5,470	2,500	1,060	623
26	323	672	463	668	575	438	2,260	2,500	5,250	2,660	1,010	700
27	366	770	463	700	546	546	2,260	3,760	5,700	2,660	1,010	776
28	344	735	438	635	518	623	1,830	5,030	6,860	2,660	970	853
29	413	668	413	575	.....	700	1,670	5,430	5,930	2,040	970	715
30	390	635	413	546	.....	635	1,510	5,210	5,250	1,900	1,010	627
31	463	.....	413	518	.....	605	.....	4,990	.....	1,760	1,010	.....

NOTE.—Gage not read Oct. 22, Nov. 5, 26, Dec. 14, 25, Feb. 11, 18, 19, Mar. 17, 28, Apr. 29, May 6, 10, 18, 22, 30, June 8, 19, July 27, 30, Aug. 6, Sept. 16, 19, and 25-27, discharge interpolated.

99664°—20—WSP 464——8

Digitized by Google

Monthly discharge of Cowlitz River at Lewis, Wash., for the year ending Sept. 30, 1917.

[Drainage area, 275 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	518	323	397	1.44	1.66	24,400
November	1,570	366	614	2.23	2.49	36,500
December	930	413	584	2.12	2.44	35,900
January	1,020	413	614	2.23	2.57	37,800
February	1,330	490	905	3.29	3.43	50,300
March	700	390	477	1.73	1.99	29,300
April	2,260	546	1,170	4.25	4.74	69,600
May	5,430	1,220	2,910	10.60	12.22	179,000
June	8,440	2,580	5,120	18.60	20.75	305,000
July	7,340	1,760	4,820	17.50	20.18	296,000
August	2,190	970	1,380	5.02	5.79	84,800
September	929	547	760	2.76	3.08	45,200
The year	8,440	323	1,650	6.00	81.34	1,190,000

COWLITZ RIVER AT MOSSY ROCK, WASH.

LOCATION.—In sec. 1, T. 12 N., R. 2 E., at county highway bridge 1 mile north of Mossy Rock, in Lewis County, and 2½ miles above mouth of Tilton River.

DRAINAGE AREA.—1,170 square miles (measured on Pl. I, Water Supply Paper 313).

RECORDS AVAILABLE.—January 1, 1912, to September 30, 1917 (fragmentary), when station was discontinued.

GAGE.—Vertical staff in three sections on left bank 100 feet above bridge; read by G. W. Jerrells. Chain gage on bridge, at different datum, was used prior to September 18, 1913.

DISCHARGE MEASUREMENTS.—Made from highway bridge.

CHANNEL AND CONTROL.—Channel above and below gage is deep canyon whose walls are almost vertical. Control is a broad riffle, 450 feet below gage, composed of sand, gravel, and boulders; shifting at high stages. Stage of zero flow, about gage height —0.9 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.0 feet on June 19 (discharge, 17,400 second-feet); minimum stage recorded, 2.00 feet October 19–28 (discharge, 975 second-feet).

1912–1917: Maximum stage recorded, 18.0 feet January 7–8, 1914 (discharge, 30,300 second-feet); flood of November, 1906, as determined by leveling from high-water marks pointed out by residents, reached a stage corresponding to about 29.4 feet on present staff gage (discharge about 51,000 second-feet); minimum stage recorded, 1.40 feet October 10–13, 1915 (discharge, 825 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed at highwater May 30. Rating curve used prior to change well defined below 10,000 second-feet; curve used after change well defined below 15,000 second-feet. Gage read once daily to half tenths. Gage-height record fairly reliable. Daily discharge ascertained by applying daily gage height to rating table. Records good.

Digitized by Google

Discharge measurements of Cowlitz River at Mossy Rock, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 7	C. O. Brown	2.34	1,300	July 29	John McCombs	5.59	5,480
May 31	John McCombs	10.70	15,000	Sept. 22	L. D. Carson	2.99	1,510

Daily discharge, in second-feet, of Cowlitz River at Mossy Rock, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,520	1,420	4,300	2,090	3,010	2,870	4,130	7,560	15,400	15,200	4,790	2,150
2	1,520	1,420	2,870	2,210	2,870	3,010	3,960	7,000	15,200	14,100	4,620	2,150
3	1,520	1,520	3,310	2,330	3,010	3,160	3,790	6,820	11,800	15,400	4,620	2,150
4	1,420	1,740	3,310	2,460	3,310	3,310	3,470	6,630	10,700	14,800	4,620	2,010
5	1,320	1,970	3,310	3,310	4,300	3,470	4,300	6,440	9,940	14,600	4,280	2,010
6	1,320	2,460	3,160	4,130	4,640	3,470	5,720	6,820	9,760	13,700	3,610	2,010
7	1,220	2,330	3,010	3,960	5,000	3,160	6,080	7,560	11,800	13,000	3,450	2,010
8	1,140	2,460	2,730	3,790	5,360	2,870	6,820	8,660	12,000	11,800	3,290	1,880
9	1,140	2,590	2,590	3,960	5,000	2,730	8,300	11,300	14,400	12,000	3,140	1,750
10	1,140	3,010	2,460	4,470	4,640	2,590	7,740	12,600	14,800	12,600	2,990	1,750
11	1,140	3,310	2,330	4,300	5,720	2,460	7,560	13,800	12,600	12,200	2,850	1,880
12	1,050	3,010	2,730	4,130	6,260	2,460	7,000	14,200	9,940	11,800	2,850	1,880
13	1,050	2,460	3,310	.....	6,440	2,330	6,630	14,000	9,760	11,500	2,850	2,010
14	1,050	2,210	4,300	.....	6,630	2,330	6,260	13,100	12,600	10,900	2,850	2,010
15	1,050	2,090	4,300	.....	6,080	2,210	5,900	12,400	14,400	11,100	2,850	1,880
16	1,050	1,970	3,960	.....	5,900	2,210	5,540	10,500	14,800	11,600	2,850	1,880
17	975	1,970	3,470	.....	5,900	2,210	5,000	9,040	15,400	11,800	2,710	1,750
18	975	1,970	3,470	.....	5,900	2,210	5,000	8,480	16,500	11,300	2,710	1,750
19	975	1,860	3,310	.....	5,720	2,330	5,000	8,300	17,400	10,700	2,710	1,750
20	975	1,740	3,310	.....	5,540	2,460	5,000	7,920	16,300	9,570	2,710	1,750
21	975	1,630	3,310	.....	5,000	2,460	5,180	7,920	15,200	8,830	2,710	1,630
22	975	1,630	3,310	.....	4,640	2,460	5,360	7,920	14,600	7,900	2,570	1,520
23	975	1,740	3,310	.....	3,960	2,460	5,540	7,920	13,000	6,980	2,570	1,520
24	975	1,740	3,310	.....	3,470	2,590	5,900	7,920	14,800	6,240	2,430	1,520
25	975	1,970	3,470	.....	3,310	2,730	6,260	8,110	14,100	5,870	2,430	1,520
26	975	3,630	2,870	.....	3,310	2,870	6,820	7,920	13,700	5,690	2,290	1,520
27	975	4,130	2,730	3,960	3,160	3,010	9,400	8,300	13,700	5,870	2,290	1,520
28	975	5,000	2,460	3,630	2,870	3,310	9,040	12,200	14,100	5,690	2,290	1,520
29	1,050	5,720	2,210	3,310	.....	3,630	8,660	14,400	15,000	5,510	2,290	1,520
30	1,220	5,000	2,170	3,160	.....	3,790	8,110	15,900	15,200	4,790	2,290	1,520
31	1,420	.....	2,130	3,010	.....	4,130	.....	15,200	.....	4,450	2,150	.....

NOTE.—No gage-height record available Jan. 13–26; mean discharge estimated as 2,900 second-feet by hydrographic comparison with flow of Cowlitz River at Lewis.

Monthly discharge of Cowlitz River at Mossy Rock, Wash., for the year ending Sept. 30, 1917.

[Drainage area, 1,170 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	1,520	975	1,130	0.966	1.11	69,500
November	5,720	1,420	2,520	2.15	2.40	150,000
December	4,300	2,130	3,120	2.67	3.08	192,000
January	4,470	2,090	3,190	2.73	3.15	196,000
February	6,630	2,870	4,680	4.00	4.16	260,000
March	4,130	2,210	2,820	2.41	2.78	173,000
April	9,400	3,470	6,120	5.23	5.84	364,000
May	15,900	6,440	9,900	8.46	9.75	609,000
June	17,400	9,760	13,600	11.6	12.94	809,000
July	15,400	4,450	10,200	8.72	10.05	627,000
August	4,790	2,150	3,020	2.58	2.97	186,000
September	2,150	1,520	1,790	1.53	1.71	107,000
The year	17,400	975	5,170	4.42	59.94	3,740,000

Digitized by Google

CLEAR FORK NEAR LEWIS, WASH.

LOCATION.—In sec. 29, T. 14 N., R. 10 E., above Yakima trail bridge, 1,000 feet above mouth, and about 7 miles northeast of Lewis, in Lewis County.

DRAINAGE AREA.—48 square miles (measured on Plate I, Water-Supply Paper 313).

RECORDS AVAILABLE.—August 30, 1907, to September 30, 1917, when station was discontinued.

GAGE.—Vertical staff on right bank 350 feet above bridge; read by J. A. Combs. Gage was washed out several times prior to 1912, but was replaced at same site and approximately same datum. Relation of present datum to that maintained before 1912 somewhat uncertain.

DISCHARGE MEASUREMENTS.—Made from cable at gage or by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and boulders; shifts during extremely high water. One channel at all stages. Stage of zero flow, according to measurements October 4, 1916, gage height -0.13 ± 0.05 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.60 feet June 16 (discharge, 1,330 second-feet); minimum stage recorded, 1.50 feet October 24 and 28 (discharge, 75 second-feet).

1907–1917: Maximum stage recorded, 7.3 feet November 23, 1909 (discharge, 2,530 second-feet); minimum stage recorded, 1.16 feet September 28, 1915 (discharge, 43 second-feet).

ICE.—Record discontinued during winter.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent. Rating curve fairly well defined. Gage read to hundredths. Daily discharge ascertained by applying daily gage height to rating table. Records good.

COOPERATION.—Gage-height record furnished by Portland Railway Light & Power Co.

Discharge measurements of Clear Fork near Lewis, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 4	C. O. Brown	1.67	96
May 26	John McCombs	2.98	417
Sept. 19	L. D. Carson	1.70	93

Digitized by Google

Daily discharge, in second-feet, of Clear Fork near Lewis, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	May.	June.	July.	Aug.	Sept.
1									124
2			108			700			
3	100			82	230				
4	94							319	
5					219		950		115
6			108	150					
7	94	115				700			
8								266	108
9			94			1,100			
10	87			168				254	
11		168			648		600		
12			141						115
13	87			132		535			
14								230	
15		108			535		816		115
16			132			1,330			
17	81			108					
18		81					880	198	
19			132		366				100
20	77			94		950			
21							756		
22		100						168	94
23			100		366	756			
24	75			94					
25		87					436	150	
26					383				87
27			87	150		700			
28	75						350		
29		132						141	
30			87		880	950			
31	108						334		

LAKE CREEK AT OUTLET OF PACKWOOD LAKE, NEAR LEWIS, WASH.

LOCATION.—In sec. 21, T. 13 N., R. 10 E., 500 feet below outlet of Packwood Lake, 5 miles east of Lewis, in Lewis County.

DRAINAGE AREA.—About 18 square miles (measured on Pl. I, Water-Supply Paper 313).

RECORDS AVAILABLE.—September 2, 1911, to September 30, 1917.

GAGE.—Vertical staff spiked to cedar tree on right bank, 32 feet upstream from weir and 500 feet below outlet; read by J. A. Combs. Zero of gage at elevation of crest of weir.

DISCHARGE MEASUREMENTS.—Made from footbridge just above weir or by wading.

CHANNEL AND CONTROL.—A rectangular weir 19.94 feet long, with crest 1 inch wide, forms control. Overflow occurs at gage height 4.4 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.62 feet, afternoon reading, June 17 (discharge, 506 second-feet); minimum stage recorded, 0.53 foot, afternoon reading, October 26 (discharge, 33 second-feet). Discharge October 24–26, at gage height 0.54 foot, also 33 second-feet.

1911–1917: Maximum stage recorded, 4.00 feet, morning reading, June 18, 1916 (discharge, 582 second-feet); minimum stage recorded, 0.48 foot, February 26 to March 3, 1915, and 0.53 foot, October 26, 1916 (discharge, 33 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined except for extremely low water. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records excellent except for extremely low water.

COOPERATION.—Gage-height record furnished by Portland Railway, Light & Power Co.

Digitized by Google

Discharge measurements of Lake Creek at outlet of Packwood Lake, near Lewis, Wash., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 5	C. O. Brown	0.70	44	Sept. 20	L. D. Carson	1.00	75
May 29	John McCombs	1.78	176	21	do	.95	72

Daily discharge, in second-feet, of Lake Creek at outlet of Packwood Lake, near Lewis, Wash., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	57	47	52	42	46	52	38	64	244	314	159	88
2	56	47	52	41	49	51	38	64	260	350	152	82
3	52	49	52	42	54	50	38	66	244	386	152	77
4	51	55	54	47	58	51	39	68	212	404	159	76
5	47	55	55	52	54	49	40	68	204	404	152	74
6	46	54	55	60	54	49	42	70	212	422	152	73
7	42	61	54	62	53	49	45	70	228	368	152	72
8	42	73	54	62	54	47	47	69	228	350	145	72
9	40	75	53	61	53	47	50	73	244	350	131	77
10	38	74	54	58	53	46	50	88	244	368	131	77
11	38	70	63	52	54	45	51	112	244	350	131	88
12	38	64	66	50	54	43	51	138	244	350	131	85
13	38	58	63	43	53	43	51	152	228	350	131	82
14	37	56	60	42	52	42	50	159	228	350	131	82
15	36	52	60	41	53	41	49	159	278	350	131	82
16	37	51	57	41	56	39	47	152	350	386	124	82
17	36	50	56	40	58	38	47	152	482	422	124	82
18	36	47	57	39	59	38	48	145	422	386	124	82
19	36	49	57	39	58	37	50	138	386	368	124	82
20	35	45	56	38	58	37	51	131	386	350	118	77
21	34	43	54	38	58	36	50	118	386	314	118	73
22	35	41	54	37	56	36	49	118	386	278	112	68
23	34	42	52	36	56	36	48	112	332	244	106	67
24	33	42	52	36	57	40	47	106	350	212	106	66
25	33	42	51	41	56	38	49	112	332	212	100	65
26	33	51	49	42	55	38	52	112	314	204	100	66
27	35	59	47	46	54	39	58	124	314	196	94	70
28	36	57	44	48	54	40	61	152	332	204	94	74
29	40	56	44	48	.....	40	66	173	332	196	94	75
30	43	54	42	47	.....	38	66	188	332	180	88	75
31	45	.....	42	47	.....	38	.....	228	.....	173	88	.....

NOTE.—Gage not read on 6 to 12 days per month from November to May, inclusive; discharge based on observer's estimate of stage when he was absent. Gage not read Sept. 5, 12, 23, 30; discharge interpolated.

Monthly discharge of Lake Creek at outlet of Packwood Lake, near Lewis, Wash., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	57	33	40.0	2,460
November	75	41	54.0	3,210
December	66	42	53.6	3,300
January	62	36	45.7	2,810
February	58	46	54.6	3,030
March	52	36	42.4	2,610
April	66	38	48.9	2,910
May	228	64	119	7,320
June	482	204	299	17,800
July	422	173	316	19,400
August	159	88	124	7,620
September	88	65	76.4	4,550
The year	482	33	106	77,000

Digitized by Google

YOUNGS RIVER BASIN.

YOUNGS RIVER NEAR ASTORIA, OREG.

LOCATION.—In NE. ¼ sec. 2, T. 6 N., R. 9 W., at MacGregor-Malone logging camp, about 4 miles above Youngs River falls, and 13 miles south of Astoria, Clatsop County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 7, 1916, to September 30, 1917.

GAGE.—Vertical staff on right bank opposite cook house; read by J. H. Morgan.

DISCHARGE MEASUREMENTS.—Made by wading at low stages; no equipment for flood measurements.

CHANNEL AND CONTROL.—Control is of rock and compact clay; channel is a succession of pools and riffles at low stages; velocities high in flood.

EXTREMES OF STAGE.—Maximum stage recorded during year, 7.4 feet at 4 p. m. March 23; minimum stage, 2.20 feet in October, August, and September.

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Gage read once daily to hundredths. Not enough discharge measurements have been made to define a rating curve.

The following discharge measurement was made by C. L. Batchelder:
August 14, 1917: Gage height, 2.26 feet; discharge, 10.3 second-feet.

Daily gage height, in feet, of Youngs River near Astoria, Oreg., for the year ending Sept. 30, 1917.

[J. H. Morgan, observer.]

Day.	Oct.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.30	.....	3.30	3.75	3.00	4.65	3.45	2.95	3.00	2.40	2.20
2	2.30	.....	3.80	4.25	3.00	4.95	3.30	3.15	3.00	2.40	2.20
3	2.30	.....	3.70	4.35	3.00	4.60	3.15	3.20	3.00	2.40	2.20
4	2.30	.....	4.20	4.25	4.15	4.95	3.00	3.10	3.00	2.40	2.20
5	2.30	.....	5.55	4.20	5.40	4.85	3.05	2.90	2.90	2.40	2.20
6	2.30	.....	4.50	3.95	4.65	4.45	3.20	2.90	2.90	2.35	2.20
7	2.30	.....	4.10	3.80	4.30	5.50	3.55	2.90	2.90	2.30	2.30
8	2.20	.....	3.90	3.70	4.35	4.80	3.50	3.05	2.80	2.30	2.30
9	2.20	.....	3.50	3.50	4.00	4.45	3.45	3.25	2.75	2.30	2.40
10	2.20	.....	3.40	3.50	3.90	4.60	3.30	3.30	2.70	2.30	2.45
11	2.20	.....	3.40	3.50	3.75	4.50	3.30	3.35	2.70	2.30	2.50
12	2.20	.....	3.40	3.40	3.70	4.35	3.15	3.25	2.70	2.30	2.50
13	2.20	.....	3.35	3.30	3.75	4.25	3.00	3.10	2.65	2.30	2.50
14	2.20	.....	3.20	3.20	3.65	4.00	3.00	3.00	2.60	2.25	2.52
15	2.20	.....	3.20	3.00	3.60	3.95	3.00	3.00	2.60	2.25	2.58
16	2.20	.....	3.00	3.50	3.50	3.80	3.05	2.90	2.60	2.25	2.45
17	2.20	.....	3.00	3.35	3.40	3.75	3.15	2.80	2.60	2.25	2.40
18	2.20	.....	2.80	3.20	3.45	3.70	3.05	2.80	2.55	2.25	2.35
19	2.20	.....	2.90	3.35	3.55	3.75	3.15	2.75	2.50	2.25	2.30
20	2.20	.....	3.10	3.40	3.90	4.35	3.10	2.75	2.50	2.25	2.25
21	2.20	.....	3.40	3.40	4.15	4.40	3.10	2.85	2.50	2.25	2.20
22	2.20	.....	3.40	3.40	5.30	4.05	3.05	2.85	2.50	2.25	2.25
23	2.20	.....	3.40	3.30	6.20	3.95	2.95	2.90	2.50	2.20	2.25
24	2.20	.....	3.30	3.20	5.75	3.80	2.90	3.80	2.50	2.20	2.30
25	2.20	.....	3.60	3.00	4.80	3.75	2.90	3.50	2.45	2.20	2.38
26	2.20	.....	3.60	3.00	4.35	3.55	2.90	3.05	2.40	2.20	2.48
27	2.20	.....	5.25	3.00	4.60	3.50	2.90	3.00	2.50	2.20	2.55
28	2.20	.....	4.75	3.00	4.50	3.50	2.80	3.20	2.50	2.20	2.50
29	2.70	.....	4.10	.....	5.20	3.60	2.80	3.35	2.50	2.20	2.42
30	3.20	2.30	3.70	.....	4.50	3.60	2.80	3.20	2.50	2.20	2.32
31	.....	3.20	3.45	.....	4.20	.....	2.80	.....	2.40	2.20	.....

Digitized by Google

STREAMS BETWEEN COLUMBIA RIVER AND KLAMATH RIVER.

ROGUE RIVER BASIN.

ROGUE RIVER BELOW PROSPECT, OREG.

LOCATION.—In sec. 6, T. 33 S., R. 3 E., at Prospect power plant of California-Oregon Power Co., 2 miles below Prospect, Jackson County, about 47 miles northeast of Medford, 1 mile below mouth of Mill Creek, and 2 miles above Middle Fork.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 3, 1913, to September 30, 1917.

GAGE.—Vertical staff on right bank about 100 feet above power house. Gage reader, O. L. Irwin.

DISCHARGE MEASUREMENTS.—Made from cable about 500 feet above gage.

CHANNEL AND CONTROL.—Control formed by large boulders; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.4 feet, June 9 (discharge, 3,540 second-feet; total, including discharge of flume, 3,680 second-feet); minimum stage recorded, 2.4 feet at 4 p. m. November 12 (discharge, 430 second-feet; total, including flume, 587 second-feet).

1913-1917: Maximum stage recorded is that of 1917; minimum stage recorded, 2.3 feet September 30 to October 3, October 10, and November 7, 1915 (discharge, 400 second-feet; total, including flume, 544 second-feet).

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—The California-Oregon Power Co.'s flume diverts around this station; a record is kept of this diversion. (See p. 124.)

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Gage read twice a day to quarter-tenths. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of Rogue River below Prospect, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 4	Batchelder and Reineking	2.65	518
June 19	C. L. Batchelder	5.02	3,010
Sept. 7	F. F. Henshaw	2.72	574

Digitized by Google

Daily discharge, in second-feet, of Rogue River below Prospect, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	532	505	505	485	485	560	780	1,800	2,740	2,250	780	595
2	505	505	505	485	485	560	820	1,800	2,610	2,250	780	595
3	532	505	560	485	505	595	780	1,800	2,490	2,250	780	595
4	532	630	630	505	505	595	780	1,800	2,370	2,250	780	595
5	532	595	630	630	505	595	860	1,800	2,490	2,250	780	560
6	532	595	560	595	505	560	1,250	2,610	2,740	2,130	700	560
7	560	560	485	560	560	560	1,250	2,740	2,870	2,020	700	560
8	505	505	505	505	560	560	1,800	2,740	3,130	1,910	700	560
9	505	505	485	505	595	560	1,580	2,870	3,540	1,800	700	560
10	505	505	485	505	630	560	1,360	2,740	3,130	1,800	700	560
11	505	505	485	505	630	532	2,020	3,000	2,740	1,690	700	560
12	505	448	485	505	665	505	1,800	3,000	2,370	1,690	700	560
13	505	465	485	505	665	505	1,640	3,000	2,370	1,690	700	560
14	505	505	485	485	700	505	1,470	3,000	2,610	1,520	665	560
15	505	505	485	465	665	505	1,360	2,740	2,870	1,470	665	560
16	505	505	505	465	700	505	1,250	2,490	3,130	1,420	630	560
17	505	485	485	465	700	505	1,150	2,490	3,130	1,360	630	560
18	485	485	485	465	700	505	1,100	2,370	3,130	1,250	630	560
19	485	505	505	465	630	505	1,050	2,250	3,130	1,250	630	560
20	505	485	630	505	630	505	1,050	2,370	3,000	1,150	630	560
21	485	485	560	505	630	505	1,360	2,250	2,870	1,100	630	560
22	485	485	505	532	630	505	1,470	2,250	2,740	1,050	630	560
23	485	485	505	532	630	505	1,800	2,250	2,490	1,050	630	560
24	485	485	505	505	630	505	2,130	2,250	2,490	950	630	560
25	485	560	485	505	780	560	2,490	2,130	2,490	950	630	560
26	485	740	485	505	665	532	2,610	2,020	2,370	950	595	560
27	485	665	465	505	630	905	2,490	2,130	2,370	860	595	560
28	485	780	485	505	640	1,250	2,250	2,490	2,370	860	630	560
29	485	560	485	505	.....	1,200	2,250	2,740	2,250	860	595	560
30	505	505	485	505	.....	1,150	2,020	2,740	2,250	820	595	560
31	560	.....	485	485	.....	950	.....	2,740	.....	780	595	.....

Monthly discharge of Rogue River at Prospect, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	560	485	506	31,100
November	780	448	535	31,800
December	630	465	51	31,400
January	630	465	506	31,100
February	780	485	616	34,200
March	1,250	505	624	38,400
April	2,610	780	1,530	91,000
May	3,000	1,800	2,430	149,000
June	3,540	2,250	2,710	161,000
July	2,250	780	1,470	90,400
August	780	595	669	41,100
September	595	560	565	33,600
The year	3,540	448	1,060	764,000

Digitized by Google

Combined monthly discharge of Rogue River and California-Oregon Power Co. flume near Prospect, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	730	642	670	41,200
November	964	605	704	41,900
December	828	573	686	42,200
January	800	597	669	41,100
February	950	642	786	43,600
March	1,420	675	796	49,000
April	2,780	944	1,700	101,000
May	3,170	1,970	2,600	160,000
June	3,680	2,420	2,880	171,000
July	2,420	964	1,640	101,000
August	964	765	841	51,700
September	765	730	715	43,700
The year	3,680	573	1,230	887,000

ROGUE RIVER NEAR TOLO, OREG.

LOCATION.—In sec. 18, T. 36 S., R. 2 W., at Ray Gold, just below dam and power house of California-Oregon Power Co., 1¼ miles below Tolo, Jackson County, 7 miles above Gold Hill, half a mile below mouth of Bear Creek.

DRAINAGE AREA.—2,020 square miles.

RECORDS AVAILABLE.—August 30, 1905, to September 30, 1917.

GAGE.—Friez water-stage recorder referred to vertical staff bolted to concrete pier of bridge near right bank. Observers, E. W. Howells and E. B. Price.

DISCHARGE MEASUREMENTS.—Made from cable 300 feet below gage.

CHANNEL AND CONTROL.—Rock and boulders; practically permanent. One channel at all stages.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 6.68 feet at 3 a. m. February 25 (discharge, 12,300 second-feet); minimum discharge less than 670 second-feet every night at 10 p. m. August 23 to September 30 (water surface below intake to recorder well).

1905–1917: Maximum stage recorded, 20.0 feet at 7.30 a. m. November 23, 1909 (discharge estimated by extension of rating curve as 60,000 second-feet); minimum stage estimated at −0.2 foot at 8 p. m. October 6 to 9 and 11 to 13, 1915 (discharge about 460 second-feet); water below intake to recorder well.

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—A large area of land is irrigated from Rogue River and its tributaries.

REGULATION.—Discharge is influenced by changes of load on power plant just above station.

ACCURACY.—Stage-discharge relation practically permanent. On the basis of measurements made in 1917 and 1918 the rating curve has been revised; new curve applicable October 1, 1916, well defined between 800 and 30,000 second-feet. Operation of water-stage recorder unsatisfactory greater part of time prior to March 21. No record November 21 to December 31. Daily discharge ascertained by use of discharge integrator whenever record was satisfactory; for other periods, except those indicated in footnote to table of daily discharge, by applying to rating table the gage reading made at 6 a. m., which gives nearly the mean for the day. Records excellent, April to September; good for rest of year.

Digitized by Google

Discharge measurements of Rogue River near Tolo, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 2	Batchelder and Reineking	1.15	1,340	June 15	C. L. Batchelder	4.02	5,580
Mar. 22	Henshaw and Briggs	2.40	2,940	Sept. 3	F. F. Henshaw	1.26	1,530

Daily discharge, in second-feet, of Rogue River near Tolo, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,180	1,220	1,360	1,540	3,290	4,800	5,860	6,640	3,840	1,690	1,290
2	1,180	1,190	1,460	1,560	2,970	6,090	5,230	6,460	3,890	1,690	1,300
3	1,180	1,180	2,660	1,720	2,960	5,120	5,220	5,940	4,100	1,680	1,380
4	1,180	1,260	2,430	2,100	3,010	4,780	5,180	5,490	3,950	1,640	1,360
5	1,180	1,420	3,780	2,340	5,580	5,850	5,360	6,080	3,780	1,580	1,370
6	1,270	1,380	3,870	2,380	4,700	6,740	6,200	6,550	3,690	1,650	1,360
7	1,270	1,380	2,870	2,460	4,190	6,670	7,750	6,670	3,480	1,560	1,360
8	1,270	1,330	2,530	2,460	4,470	8,590	7,560	7,060	3,400	1,540	1,360
9	1,270	1,310	2,140	2,440	4,760	7,220	7,590	8,190	3,300	1,550	1,360
10	1,270	1,290	1,970	2,420	5,040	6,310	7,410	7,260	3,150	1,530	1,380
11	1,340	1,260	1,900	2,970	3,540	8,980	7,760	6,110	2,960	1,490	1,400
12	1,300	1,240	1,830	3,380	2,940	8,850	8,120	5,310	2,940	1,490	1,400
13	1,290	1,220	1,680	3,210	2,800	7,100	9,020	5,120	2,800	1,520	1,420
14	1,240	1,220	1,520	2,870	2,840	6,130	7,600	5,140	2,710	1,490	1,420
15	1,230	1,180	1,460	2,560	2,620	5,920	8,380	5,450	2,680	1,520	1,330
16	1,250	1,180	1,220	2,630	2,660	5,190	7,820	6,180	2,610	1,490	1,310
17	1,270	1,270	1,010	2,970	2,800	4,790	8,110	6,530	2,530	1,490	1,420
18	1,270	1,270	1,140	2,600	2,940	4,140	7,930	6,360	2,410	1,490	1,300
19	1,250	1,270	1,320	2,600	2,940	3,930	6,960	6,520	2,320	1,380	1,320
20	1,250	1,360	1,420	2,530	2,870	4,270	6,760	6,310	2,190	1,400	1,340
21	1,230	.....	1,470	2,530	3,270	5,240	6,630	6,100	2,140	1,390	1,310
22	1,220	.....	1,450	2,530	2,730	6,050	6,440	5,660	2,090	1,350	1,300
23	1,200	.....	1,430	2,530	2,650	6,700	6,080	5,210	2,060	1,360	1,260
24	1,210	.....	1,380	3,630	3,170	7,630	5,720	4,630	1,990	1,340	1,410
25	1,200	.....	1,380	8,720	4,410	8,660	5,420	4,500	1,940	1,380	1,330
26	1,220	.....	1,400	5,040	3,900	9,100	5,020	4,360	1,900	1,380	1,360
27	1,220	.....	1,410	5,400	8,940	8,230	5,230	4,360	1,840	1,370	1,230
28	1,220	.....	2,800	3,440	8,920	7,170	5,890	4,300	1,810	1,350	1,280
29	1,180	.....	2,450	.....	8,980	7,110	6,540	4,090	1,760	1,340	1,300
30	1,210	.....	2,250	.....	7,320	6,110	6,440	3,900	1,740	1,330	1,280
31	1,220	.....	1,880	.....	5,450	.....	6,540	.....	1,730	1,330	.....

NOTE.—Mean discharge estimated Nov. 21–31, 1,440 second-feet; Dec. 1–31, 1,350 second-feet. Discharge interpolated Oct. 16, 21–22, Nov. 9–12, Jan. 22, and Mar. 8–9.

Monthly discharge of Rogue River near Tolo, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,340	1,180	1,230	75,600
November	.....	1,180	1,330	79,100
December	.....	.....	1,350	83,000
January	3,870	1,010	1,900	117,000
February	8,720	1,540	2,990	166,000
March	8,980	2,620	4,180	257,000
April	9,100	3,930	6,450	384,000
May	9,020	5,020	6,700	412,000
June	8,190	3,900	5,750	342,000
July	4,100	1,730	2,700	166,000
August	1,690	1,330	1,480	91,000
September	1,420	1,230	1,340	79,700
The year	9,100	1,010	3,110	2,250,000

Digitized by Google

CALIFORNIA-OREGON POWER CO.'S FLUME NEAR PROSPECT, OREG.

LOCATION.—In sec. 6, T. 33 S., R. 3 E., at lower end of power flume, just above forebay, and about 2 miles below Prospect, Jackson County.

RECORDS AVAILABLE.—August 1, 1913, to September 30, 1917.

GAGE.—Vertical staff in stilling box on right side of flume, about 500 feet above forebay, used after August 17, 1915. Gage one mile above forebay used August 1, 1913, to August 16, 1915. Gage reader, Geo. Walker.

DISCHARGE MEASUREMENTS.—Made from collar of flume.

CHANNEL AND CONTROL.—Wooden flume at the end of which there is a free fall into the forebay.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.6 feet December 7–9 and 17–23 (discharge, 198 second-feet); minimum stage recorded, 1.9 feet, December 27 (discharge, 108 second-feet).

1916–1917: Maximum stage recorded, 2.7 feet April 25, 26, 30, May 1 and 2, 1916 (discharge, 212 second-feet); minimum stage was that of 1917.

ICE.—Stage-discharge relation never affected by ice.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined. Gage read once daily to half-tenths. Daily discharge ascertained by applying daily gage height to rating table. Records good.

The California-Oregon Power Co.'s flume diverts water from Rogue River in the SE. ¼ sec. 30, T. 32 S., R. 3 E., and delivers it to the power plant in the NW. ¼ sec. 6, T. 33 S., R. 3 E., where a head of about 500 feet is utilized.

The following discharge measurement was made by Batchelder and Reineking:

October 4, 1916: Gage height, 2.30 feet; discharge, 162 second-feet.

Daily discharge, in second-feet, of California-Oregon Power Co.'s flume near Prospect, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	157	170	184	184	157	177	164	170	170	170	184	170
2	164	170	184	184	170	170	157	170	170	170	184	170
3	170	170	184	184	170	170	170	170	170	170	184	170
4	164	170	184	170	170	170	170	170	170	170	184	170
5	170	157	191	170	170	170	184	170	157	170	170	170
6	170	157	191	170	170	170	184	170	157	170	170	170
7	157	157	198	184	170	170	157	170	144	170	170	170
8	157	144	198	184	170	170	157	170	144	177	170	170
9	157	170	198	170	170	170	170	170	144	184	170	170
10	157	144	144	170	170	170	170	170	170	184	170	170
11	157	144	157	170	164	170	170	170	170	170	170	170
12	157	157	157	144	164	170	170	170	157	170	170	170
13	157	157	132	144	170	170	184	170	157	170	170	170
14	157	170	132	144	170	177	184	170	144	170	170	170
15	157	170	144	144	170	177	184	170	170	170	170	170
16	164	170	144	132	184	170	184	170	170	170	170	170
17	164	170	198	132	184	170	184	170	170	170	170	170
18	157	170	198	144	170	170	177	170	170	170	170	170
19	170	170	198	144	170	170	177	170	170	170	170	170
20	170	170	198	144	170	170	184	170	170	170	170	170
21	164	170	198	157	170	170	184	170	170	170	170	170
22	157	184	198	157	170	170	170	170	170	170	170	170
23	157	184	198	170	170	170	170	170	170	177	170	170
24	170	184	184	170	170	170	157	170	170	184	170	170
25	170	184	144	170	170	184	157	170	170	184	170	170
26	170	184	132	170	170	184	170	170	170	184	170	170
27	170	184	108	170	170	184	157	157	170	184	170	170
28	170	184	184	170	177	170	157	157	170	184	170	170
29	170	184	184	170	.....	170	170	157	170	177	170	170
30	170	184	184	170	.....	170	170	170	170	177	170	170
31	170	.....	184	157	.....	170	.....	170	.....	184	170	.....

Digitized by Google

Monthly discharge of California-Oregon Power Co.'s flume near Prospect, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	170	157	164	10,100
November	184	144	169	10,100
December	198	108	175	10,800
January	184	132	163	10,000
February	184	157	170	9,440
March	184	170	172	10,600
April	184	157	171	10,200
May	170	157	169	10,400
June	170	144	165	9,820
July	184	170	175	10,800
August	184	170	172	10,600
September	170	170	170	10,100
The year	198	108	169	123,000

SOUTH FORK OF LITTLE BUTTE CREEK NEAR DEADWOOD, OREG.

LOCATION.—In sec. 9, T. 38 S., R. 4 E., about 1½ miles east of Deadwood, 4 miles east of Lilyglen, and 21 miles east of Ashland, Jackson County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April to July, 1917.

GAGE.—Barrett & Lawrence water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made from foot log or by wading.

CHANNEL AND CONTROL.—Gravel and boulders; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 2.08 feet at 2 a. m. June 19 (discharge, 60 second-feet); probably no flow on January 19, 1917.

DIVERSIONS.—None at present. Water can be diverted above station and stored in the proposed Beaver Creek reservoir.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve poorly defined. Operation of water-stage recorder satisfactory May 4 to July 24. Discharge estimated April 1 to May 3 and July 25–31. Determinations of daily discharge not sufficiently accurate to warrant publication. Records of monthly discharge fair for May and June, poor for April and July.

Discharge measurements of South Fork of Little Butte Creek near Deadwood, Oreg., during the year ending Sept. 30, 1917.

[Made by F. C. Dillard.[a]]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
June 7	1.90	48.8
July 24	.78	4.5

[a] Engineer, Talent irrigation district.

Monthly discharge of South Fork of Little Butte Creek near Deadwood, Oreg., for the year ending Sept. 30, 1917.

Month—	Mean discharge in second-feet.	Run-off (total in acre-feet).	Month—	Mean discharge in second-feet.	Run-off (total in acre-feet).
April	7.7	458	July	11.3	695
May	33.5	2,060			
June	48.4	2,880	The period		6,090

Digitized by Google

LITTLE BUTTE CREEK ABOVE EAGLE POINT, OREG.

LOCATION.—In sec. 31, T. 35 S., R. 1 E., at Bieberstedt's ranch, a quarter of a mile above intake of Eagle Point ditch, about 3 miles east of Eagle Point, Jackson County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 24, 1916, to September 30, 1917.

GAGE.—Vertical staff; low-water section nailed to stump on right bank; high-water section on left bank directly opposite. Gage reader, Carl Bieberstedt.

DISCHARGE MEASUREMENTS.—Made from foot-bridge or by wading.

CHANNEL AND CONTROL.—Channel of smooth gravel; fairly deep and narrow. Control is diversion dam of Eagle Point ditch which may be changed occasionally.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.25 feet at 11.30 a. m., May 17 (discharge, 1,430 second-feet); minimum stage recorded, 1.98 feet at 7.40 a. m. November 21, at 8.10 a. m. December 17, at 8.10 a. m. December 29, and at 8.30 a. m. January 16 (discharge, 30 second-feet).

1916–1917: Maximum stage was recorded in 1917. Minimum stage recorded, 1.70 feet August 2, 1916 (discharge, 20 second-feet). The flood of 1884 is said to have reached a stage of about 15 feet.

ICE.—Stage-discharge relation not affected by ice.

DIVERSIONS.—The Rogue River Valley canal diverts water above the station (see p. 130) and the municipal water supply (about 7.5 second-feet) for Medford is taken out above. Several hundred acres are irrigated along the creek above the station. The Eagle Point ditch diverts about 8 second-feet just below this station but above former station at Tronson's ranch.

REGULATION.—Water was being stored in Fish Lake reservoir November 10 to June 4 and was released October 2 to 15, June 4 to 12, and during September. Not much change at other times.

ACCURACY.—Stage-discharge relation changed in January; not affected by ice. Rating curves well defined between 30 and 600 second-feet; applicable October 1 to January 28 and January 29 to September 30, respectively. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records excellent below 600 second-feet.

Discharge measurements of Little Butte Creek above Eagle Point, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 5	Batchelder and Reinckling.	3.02	171	June 17	Batchelder and Cowgill.[a]	4.25	547
Mar. 22	Henshaw and Briggs...	3.32	241	Aug. 1	R. P. Cowgill.....	2.20	53
				Sept. 6	F. F. Henshaw.....	2.35	66

[a] Chief engineer, Rogue River Valley Canal Co.

Digitized by Google

Daily discharge, in second-feet, of Little Butte Creek above Eagle Point, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	68	75	33	59	112	292	490	600	600	188	50	57
2	70	75	33	278	92	264	680	560	560	166	49	60
3	80	73	37	292	137	251	490	560	525	156	51	60
4	146	78	39	188	238	320	455	525	525	146	53	62
5	177	84	39	525	200	920	640	525	1,150	146	49	62
6	177	89	38	306	188	455	640	600	1,050	128	48	64
7	177	89	35	200	188	438	640	720	920	128	46	69
8	177	83	35	146	166	320	920	680	840	128	46	69
9	166	80	35	112	156	385	680	720	800	112	48	72
10	177	76	37	96	166	385	560	680	760	112	47	73
11	188	49	37	84	251	306	1,000	720	680	92	45	78
12	166	70	44	75	292	238	760	800	600	78	44	78
13	137	48	44	76	225	385	600	960	455	85	46	85
14	104	41	48	80	177	292	640	920	368	85	49	78
15	83	31	43	65	146	238	560	1,000	385	71	47	78
16	73	31	47	48	200	212	525	920	438	68	48	73
17	73	31	43	59	188	264	402	1,200	525	68	49	73
18	73	31	41	70	156	251	350	880	525	73	48	73
19	73	33	54	69	146	225	320	800	490	71	47	73
20	73	31	112	60	188	251	368	760	438	71	47	73
21	70	30	80	68	188	385	490	720	385	71	44	73
22	70	31	69	69	212	238	680	680	368	71	38	73
23	70	31	64	58	238	238	720	640	320	71	40	78
24	70	31	71	53	525	455	760	600	320	71	43	85
25	70	35	65	53	760	455	880	560	292	68	48	78
26	70	64	60	53	490	455	880	525	264	61	50	78
27	70	47	58	53	420	1,150	840	525	251	57	48	78
28	73	48	54	640	402	760	800	560	238	54	46	73
29	73	38	44	200	.....	1,100	680	600	225	54	47	73
30	76	34	57	212	.....	760	640	600	212	54	46	69
31	76	.....	69	137	.....	525	.....	600	.....	52	47	.....

Monthly discharge of Little Butte Creek above Eagle Point, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	188	68	105	6,460
November	89	30	52.9	3,150
December	112	33	50.5	3,110
January	640	48	145	8,920
February	760	92	245	13,600
March	1,150	212	426	26,200
April	1,000	320	636	37,800
May	1,200	525	701	43,100
June	1,150	212	517	30,800
July	188	52	92.1	5,660
August	53	38	46.9	2,880
September	85	57	72.3	4,300
The year	1,200	30	257	186,000

DEAD INDIAN CREEK NEAR LILYGLEN, OREG.

LOCATION.—In NW. ¼ sec. 22, T. 38 S., R. 3 E., at Neill's ranch, about a-mile west of Lilyglen, a former post office, and about 17 miles east of Ashland, Jackson County.

DRAINAGE AREA.—Not measured; no adequate maps available.

RECORDS AVAILABLE.—February 16, 1916, to June 30, 1917.

GAGE.—Stevens' 8-day water-stage recorder installed in October, 1916. Vertical staff on left bank, one-eighth mile upstream used up to May, 1916. Observer, William Lindsay.

Digitized by Google

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Closely packed clay; practically permanent.

EXTREMES OF DISCHARGE.—1916–17: Maximum stage recorded, 3.12 feet at 4 p. m. March 29, 1917; probably caused by backwater from ice jams; discharge uncertain. Minimum stage recorded, 0.15 foot November 20, 1917 (discharge estimated, 0.1 second-foot).

ICE.—Stage-discharge relation affected by ice from November 12 to March 29. Discharge estimated from observer's notes and temperature records.

DIVERSIONS.—None at present. Water can be diverted from a point about 1,500 feet above the gage into the proposed Beaver Creek reservoir.

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent. Rating curve fairly well defined between 0.5 and 100 second-feet. Water-stage recorder worked satisfactorily except during winter when float was frozen in well. Daily discharge ascertained by applying to the rating table the mean daily gage height determined by inspecting recorder graph. Records October to March, poor because no discharge measurements were made; April to June, good.

Discharge measurements of Dead Indian Creek near Lilyglen, Oreg., during the year ending Sept. 30, 1917.

[Made by F. C. Dillard.[a]]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 19	0.20	0.4	Apr. 23	0.92	49.3
Apr. 12	.60	15.7	May 10	1.03	57

[a] Engineer, Talent irrigation district.

Daily discharge, in second-feet, of Dead Indian Creek near Lilyglen, Oreg., for the year ending Sept. 30, 1917.

Day.	Mar.	Apr.	May.	June.	Day.	Mar.	Apr.	May	June
1		116	28	52	16		9	51	16
2		25	28	52	17		9	49	16
3		4	33	47	18		8	42	14
4		4	37	47	19		8	40	14
5		8	35	36	20		11	40	14
6		11	47	33	21		15	37	11
7		13	51	34	22		16	36	11
8		15	50	36	23		37	36	9
9		12	54	36	24	2	45	36	9
10		13	54	34	25		45	36	7
11		18	61	29	26		51	38	7
12		15	77	26	27		51	42	7
13		14	90	21	28		48	48	7
14		12	78	16	29		35	49	5
15		11	67	16	30	206	30	52	5
					31	170		52	

NOTE.—Discharge estimated 2 second-feet, Feb. 1–12; 5 second-feet, Feb. 13–18; 10 second-feet, Feb. 19–28; 5 second-feet, Mar. 1–5; 2 second-feet, Mar. 6–9; 0.5 second-foot, Mar. 10–23; 50 second-feet, Mar. 25–26; 100 second-feet, Mar. 27–29.

Digitized by Google

Monthly discharge of Dead Indian Creek near Lilyglen, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October			a 0.5	31
November			a .5	30
December			a 1.0	61
January			a .5	31
February			5.5	305
March	206		26.4	1,620
April	116	4	23.6	1,400
May	90	28	47.5	2,920
June	52	5	22.2	1,320
The period				7,720

a Estimated.

NORTH FORK OF LITTLE BUTTE CREEK NEAR LAKE CREEK, OREG.

LOCATION.—In sec. 21, T. 36 S., R. 2 E., about one-eighth mile above intake of Rogue River Valley canal, 1 mile above Lake Creek post office, Jackson County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 20 to October 13, 1916; May 7 to September 30, 1917. At station above city intake, about 3 miles above present station, September 10, 1911, to March 31, 1913 (gives discharge slightly greater than present station gives).

GAGE.—Vertical staff on right bank. Gage reader, Will Mann.

DISCHARGE MEASUREMENTS.—Made by wading near gage.

CHANNEL AND CONTROL.—Boulders and gravel; fairly permanent except in extreme floods.

EXTREMES OF DISCHARGE.—Maximum discharge during period May 7 to September 30, 1917, about 700 second-feet on June 5 (estimated from records on Little Butte Creek above Eagle Point). Minimum stage recorded, 2.1 feet August 21 to 31 (discharge, 60 second-feet).

1916–1917: Maximum stage is that of 1917. Minimum stage, 1.8 feet August 24 to September 1, 1916 (discharge, 38 second-feet).

ICE.—Stage-discharge relation practically never affected by ice.

DIVERSIONS.—Pipe line for water supply of city of Medford, capacity about 7.5 second-feet, carries water past the gage. Several hundred acres irrigated above the station.

REGULATION.—Water was stored in Fish Lake reservoir, about 15 miles above the station, November 10 to June 4, and was released October 2 to 15, June 4 to 12, and during September; little change at other times.

ACCURACY.—Stage-discharge relation changed during flood of June 5 to 7. Two rating curves used; well-defined below 250 second-feet. Gage read every other day to tenths. Daily discharge ascertained by applying the gage reading to rating table. Records only fair on account of inaccurate gage readings.

Discharge measurements of North Fork of Little Butte Creek near Lake Creek, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Oct. 5	Batchelder and Reineking	2.65	190
June 17	Batchelder and Cowgill	2.68	192
Sept. 5	F. F. Henshaw	2.23	83

Digitized by Google

Daily discharge, in second-feet, of North Fork of Little Butte Creek near Lake Creek, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	May.	June.	July.	Aug.	Sept.	Day.	Oct.	May.	June.	July.	Aug.	Sept.
1	75		a 110		78		16			144	78		98
2			110	98		78	17		176	192		78	
3	75		a 110		78		18			198	78		88
4			110	98		78	19		176	a 184		78	
5	176		700		78	84	20			170	98		88
6			600	98		88	21		152	a 157		60	
7	176	130	500		78		22			144	78		88
8			460	98		88	23		130	a 144		60	
9	176	130	a 395		78		24			144	78		88
10			330	98		98	25		130	a 132		60	
11	176	130	a 312		120		26			120	78		98
12			295	78		98	27		110	a 120		60	
13	130	130	a 196		78		28			120	78		98
14			98	78		98	29		110	a 120		60	
15		176	a 121		78		30			120	78		
							31		110			60	

a Interpolated.

NOTE.—Daily discharge June 5-7 estimated from records on Little Butte Creek above Eagle Point. The increase in discharge was due to release of water at Fish Lake. No record Oct. 14 to May 6.

Monthly discharge of North Fork of Little Butte Creek near Lake Creek, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
May 7-31	176	110	138	6,840
June	700	98	222	13,200
July		78	86.0	5,290
August	120	60	73.9	4,540
September			90.9	5,410
The period				35,300

NOTE.—Monthly mean discharge is average of discharge given in daily discharge table.

ROGUE RIVER VALLEY CANAL NEAR BROWNSBORO, OREG.

LOCATION.—In SW. ¼ sec. 8, T. 36 S., R. 1 E., at head of Bradshaw drop, about 2 miles southwest of Brownsboro, 8 miles below intake, and 16 miles from Medford, Jackson County.

RECORDS AVAILABLE.—Irrigation seasons of 1913 and 1915 to 1917.

GAGE.—Vertical staff just at head of drop, installed June 5, 1916. Former gages were a few feet upstream. Gage reader, Wills Mann.

DISCHARGE MEASUREMENTS.—Made by wading or from a plank.

CHANNEL AND CONTROL.—Solid rock at head of drop; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during season, 2.0 feet June 19 to August 20 (discharge, 41 second-feet). Canal dry during winter.

1913 and 1915-1917: Maximum discharge, 41 second-feet in 1916 and 1917. Canal dry at times.

ACCURACY.—Stage-discharge relation practically permanent during season. Rating curve fairly well defined. Gage read every other day to tenths. Discharge ascertained by applying gage height to rating table. Records fair.

The Rogue River Valley canal diverts water from North Fork of Little Butte Creek in the SE. ¼ sec. 22, T. 36 S., R. 2 E., to irrigate land lying in the basin of Bear Creek. Any seepage or return water from irrigation of about 300 acres above this point reaches Little Butte Creek above the station above Eagle Point.

Digitized by Google

Discharge measurements of Rogue River Valley canal near Brownsboro, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
June 17	Batchelder and Cowgill	1.90	37.7
Sept. 5	F. F. Henshaw	1.83	30.9

Daily discharge, in second-feet, of Rogue River Valley canal near Brownsboro, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	May.	June.	July.	Aug.	Sept.	Day.	Oct.	May.	June.	July.	Aug.	Sept.
1			21	41		30	16		17		41	41	
2	24				41		17			35	41		21
3			21	41		30	18		14			41	
4					41		19			41	41		21
5			17	41		30	20		14			41	
6					41		21			41	41		21
7	7		21	41		25	22		11			35	
8		14			41		23			41	41		21
9			25	41		25	24		11			35	
10		14			41		25			41	41		17
11			30	41		25	26		11			35	
12		14			41		27			41	41		17
13			30	41		21	28		11			35	
14		14			41		29			41	41		14
15			41	41		21	30		11			30	
							31				41		

Monthly discharge of Rogue River Valley canal near Brownsboro, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October (13 days)			[a] 11.0	283
May 8-31	17	11	13.0	619
June	41	17	32.5	1,930
July	41	41	41.0	2,520
August	41	30	38.7	2,380
September	30	14	22.6	1,340

[a] Estimated from unpublished records at intake.

NOTE.—Monthly mean discharge is mean of discharge for days on which gage was read.

BEAR CREEK AT MEDFORD, OREG.

LOCATION.—In NW. ¼ sec. 30, T. 37 S., R. 1 W., just above Main Street Bridge in Medford, Jackson County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 13, 1915, to July 11, 1917; fragmentary.

GAGE.—Vertical staff at southeast corner of Page theater building, on left bank. Gage reader, R. P. Cowgill.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading; conditions favorable.

CHANNEL AND CONTROL.—Channel of loose gravel; a concrete sewer passing under creek forms a partial control.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.50 feet at 8 a. m. and 6 p. m. March 27 (discharge, 580 second-feet). Minimum discharge for year probably close to that of September 3; estimated 1.2 second-feet (water below gage).

1915–1917: Maximum stage recorded, 4.75 feet at 8 a. m. February 10, 1919 (discharge, 1,240 second-feet); minimum stage recorded, 1.25 feet August 20, 1915 (discharge, 0.2 second-foot or less).

ICE.—Stage-discharge relation unaffected.

DIVERSIONS.—A large area above the station is irrigated from the flood waters of Bear Creek.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed some time between June 2 and 14. Rating curves fairly well defined between 50 and 350 second-feet. Gage read to hundredths daily on days for which discharge is published. Daily discharge ascertained by applying daily gage height to rating table. Records good, February to May; poor, November to January; and fair, June and July.

Discharge measurements of Bear Creek at Medford, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Mar. 22	Henshaw and Briggs	2.29	136
June 16	C. L. Batchelder	1.90	73

Daily discharge, in second-feet, of Bear Creek at Medford, Oreg., for the year ending Sept. 30, 1917.

Day.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1			20	111	272	175	160	31
2				102	350	160	160	27
3				102	270	160	145	23
4	35			370	250	160	135	19
5		54	54	290	350	160	125	15
6		68		220	370	200	118	12
7			60	160	370	220	110	10
8			60	160	430	220	110	8
9			60	160	330	220	105	6
10			60	174	272	220	105	4
11			78	174	418	220	105	2
12				160	430	300	100	
13			98	160	320	330	95	
14			78	147	250	300	90	
15				134	220	290	84	
16				122	220	370	78	
17			116	134	204	430	77	
18	20				189	490	77	
19			68		189	338	76	
20					189	390	72	
21					255	340	69	
22				142	330	290	66	
23			68	118	370	240	61	
24		23		160	450	210	56	
25			512	189	450	175	50	
26			255	204	450	140	45	
27			204	580	410	140	42	
28			166	490	350	150	40	
29				526	270	150	38	
30		41		490	200	160	35	
31	20					160		

NOTE.—Discharge Nov. 27, 1916, 35 second-feet. Discharge estimated by hydrographic comparison with Little Butte and Beaver Creeks on the following dates: April 2–5, 9, 13, 14, 29, 30, May 1, 3–10, 12–14, 21–31, June 3–10, 12, 13, 15, 17–18, 20–21, 23–25, 27–29, and July 1–11.

Digitized by Google

Monthly discharge of Bear Creek at Medford, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
March	580	102	215	13,200
April	450	189	314	18,700
May	490	140	226	13,900
June	160	35	87.6	5,210
July 1-11	31	2	14.3	312
The period				51,300

PHOENIX DITCH AT TALENT, OREG.

LOCATION.—In NW. ¼ sec. 23, T. 38 S., R. 1 W., about a quarter of a mile below an old bridge across Bear Creek and half a mile north of Talent, Jackson County.

RECORDS AVAILABLE.—April 19, 1916, to September 30, 1917.

GAGE.—Vertical staff on left of flume about 80 feet below intake. Gage reader, V. D. Brophy, ditch rider.

DISCHARGE MEASUREMENTS.—Made from collar of flume.

CHANNEL AND CONTROL.—Flume extends only a few feet below gage; no defined control.

EXTREMES OF DISCHARGE.—Maximum discharge recorded during period of record, 28 second-feet June 22, 23, and 25, 1917 (gage height, 2.2 feet). Canal dry in winter.

ACCURACY.—Stage-discharge relation practically permanent except from about June 28 to July 8, when there was probably a temporary obstruction which caused backwater at the station. Rating curve well defined. Gage read to hundredths about every other day. Daily discharge ascertained by applying daily gage height directly to rating table except for June 28 to July 8, for which period shifting control method was used. Records fair.

Discharge measurements of Phoenix ditch at Talent, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
June 16	Batchelder and Cowgill[a]	1.85	19.1	July 23	R. P. Cowgill	1.25	5.8
July 5	R. P. Cowgill	2.45	26.1	27	do	1.05	3.4
12	do	1.68	14.9	31	do	.73	1.2

[a] Chief engineer, Rogue River Valley Canal Co.

Daily discharge, in second-feet, of Phoenix ditch at Talent, Oreg., for the year ending Sept. 30, 1917.

Day.	May.	June.	July.	Aug.	Day.	May.	June.	July.	Aug.
1		5.2	25.0	1.2	16	3.0	19.2	16.0	
2		4.5	26.0	1.2	17	.0	19.2	18.0	
3		3.7	26.0	1.2	18	1.0	19.6	15.5	
4		3.0	26.0	.0	19	1.0	20.1	13.8	
5		7.0	26.1		20	.0	20.5	12.0	
6		5.0	24.0		21	.0	21.8	10.0	
7		3.0	22.0		22	5.2	28.0	8.0	
8		11.0	20.0		23	3.9	28.0	6.1	
9		12.0	18.0		24	2.6	16.4	5.5	
10	1.5	13.0	16.8		25	3.0	28.0	4.8	
11	1.4	11.5	15.9		26	2.7	24.9	4.0	
12	1.4	10.0	15.0		27	2.5	21.8	3.5	
13	1.3	12.0	13.5		28	2.2	23.0	2.9	
14	1.2	15.5	12.0		19	3.1	24.0	2.4	
15	2.1	20.5	14.0		30	4.0	24.0	1.8	
					31	2.6		1.2	

NOTE.—Ditch dry except during irrigation season.

Digitized by Google

Monthly discharge of Phoenix ditch at Talent, Oreg., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
May 10-31	5.2	0	2.08	91
June	28	3.0	15.8	940
July	26.1	1.2	13.7	842
August 1-4	1.2	0	.12	7
The period				1,880

COQUILLE RIVER BASIN.

SOUTH FORK OF COQUILLE RIVER AT POWERS, OREG.

LOCATION.—In SW. ¼ sec. 13, T. 31 S., R. 12 W., a quarter of a mile due west of Powers post office, Coos County, at present terminus of Willamette Pacific Railroad, 200 feet above Bingham Creek and 1,000 feet below Salmon Creek.

DRAINAGE AREA.—168 square miles (measured on topographic map and on Douglas County Abstract Co.'s map).

RECORDS AVAILABLE.—September 4, 1916, to September 30, 1917.

GAGE.—Inclined staff in three sections on left bank under footbridge. Gage reader, B. F. Segur.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—Gravel and solid rock; shifts during floods.

EXTREMES OF DISCHARGE.—Maximum stage during period covered by record, 8.0 feet at 8 a. m. March 29 and April 11 (discharge, 5,300 second-feet). Minimum discharge, 23 second-feet October 26 (gage height, 2.58 feet).

ICE.—Stage-discharge relation never affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changed during high water of April. Two rating curves used; both fairly well defined. Gage read to hundredths once daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good for September and October, 1916, and from July to September, 1917; fair, November to June.

Discharge measurements of South Fork of Coquille River at Powers, Oreg., during the period Sept. 4, 1916, to Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Sept. 4	W. E. Dickinson	3.00	64	Jan. 9	M. S. Kelley	5.15	1,130
4	do	2.98	65	10	do	5.05	1,060
4	do	2.98	62	July 6	do	2.98	90
Oct. 21	M. S. Kelley	2.60	24.9	6	do	2.98	88
Jan. 8	do	5.50	1,500	Aug. 22	do	2.55	36
9	do	5.20	1,200				

Digitized by Google

Daily discharge, in second-feet, of South Fork of Coquille River at Powers, Oreg., from Sept. 4, 1916, to Sept. 30, 1917.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	31	81	585	470	865	650	1,610	1,100	408	116	50	32
2	.....	35	54	1,610	1,400	940	585	1,610	950	376	116	50	32
3	.....	32	181	4,760	1,830	1,200	585	2,070	915	343	114	50	32
4	66	31	1,500	3,380	1,400	1,300	650	1,720	845	323	104	48	32
5	54	31	790	3,220	4,220	1,400	1,830	2,770	810	303	93	47	32
6	49	30	2,340	2,620	3,380	1,300	1,300	2,480	1,020	284	93	46	32
7	44	29	1,500	1,830	2,070	1,200	1,100	3,220	1,020	266	84	45	32
8	44	28	790	1,830	1,500	1,100	1,200	3,540	950	266	84	44	34
9	46	28	498	1,830	1,150	940	1,200	2,770	1,020	266	84	43	38
10	45	27	398	1,300	1,100	865	1,100	2,070	950	232	75	42	38
11	41	27	314	1,060	1,060	942	1,100	5,300	950	232	75	42	40
12	40	27	224	828	940	1,020	940	3,870	880	216	75	41	40
13	38	27	224	720	790	902	865	2,920	810	200	71	40	44
14	38	27	192	650	685	755	865	2,920	690	185	68	40	44
15	37	27	168	555	585	650	720	2,480	630	185	68	40	42
16	37	27	148	525	498	650	720	1,610	605	185	68	39	42
17	35	26	126	498	445	585	720	1,400	1,020	170	68	39	42
18	35	25	121	445	420	555	790	1,200	880	163	61	39	42
19	34	26	126	445	375	790	790	1,020	750	156	61	38	42
20	34	25	121	790	354	720	790	1,830	750	142	61	38	40
21	33	25	116	1,500	445	650	1,200	1,500	750	142	61	37	40
22	33	25	113	1,950	445	790	1,020	2,070	690	142	58	36	40
23	32	24	118	2,070	445	790	1,200	2,200	605	137	56	36	37
24	31	24	116	1,500	420	865	3,870	2,340	605	129	55	35	38
25	31	23	3,220	1,100	420	1,200	3,380	2,030	592	126	54	35	37
26	31	23	3,070	790	420	1,100	2,480	1,720	580	124	52	34	34
27	31	25	2,340	755	498	1,100	2,770	1,500	580	116	52	34	33
28	31	26	1,950	828	3,220	790	3,220	1,400	555	116	52	34	33
29	31	25	1,150	685	2,770	.....	5,300	1,300	530	109	52	34	32
30	31	35	790	585	1,830	.....	2,770	1,200	480	109	52	34	31
31	.....	57	.....	525	1,150	.....	2,070	.....	430	.....	51	33	.....

Monthly discharge of South Fork of Coquille River at Powers, Oreg., for the period Sept. 4, 1916, to Sept. 30, 1917.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1916.						
September 4–30	66	31	38.2	0.227	0.23	2,050
1916–17.						
October	57	23	28.3	0.168	.19	1,740
November	3,220	54	763	4.54	5.06	45,400
December	4,760	445	1,350	8.04	9.27	83,000
January	4,220	354	1,180	7.02	8.09	73,600
February	1,400	555	927	5.52	5.75	51,500
March	5,300	585	1,540	9.17	10.57	94,700
April	5,300	1,020	2,190	13.00	14.50	130,000
May	1,100	430	772	4.60	5.30	47,500
June	408	109	205	1.22	1.36	12,200
July	116	51	72.1	.429	.49	4,430
August	50	33	40.1	.239	.28	2,470
September	44	31	36.9	.220	.25	2,200
The year	5,300	23	757	4.51	61.11	548,000

Digitized by Google

UMPQUA RIVER BASIN.

UMPQUA RIVER NEAR ELKTON, OREG.

LOCATION.—In sec. 8, T. 23 S., R. 7 W., at falls, 4 miles south (by road) from Elkton, Douglas County, and 8 miles (by river) above Elk Creek.

DRAINAGE AREA.—3,680 square miles.

RECORDS AVAILABLE.—October 18, 1905, to December 31, 1906; May 12, 1907, to September 30, 1917.

GAGE.—Staff in five sections. Low-water section inclined, the others vertical. Datum lowered 0.52 foot September 2, 1910. Gage reader, D. C. Higginbotham.

DISCHARGE MEASUREMENTS.—Made from ferry 100 feet below gage.

CHANNEL AND CONTROL.—Channel of gravel; somewhat shifting. Control of rock; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.8 feet at 6 p. m. March 25 (discharge, 40,300 second-feet); minimum stage recorded, 0.30 foot October 1 to 30 and September 8 and 9 (discharge 1,140 second-feet).

1905-1917: Maximum stage recorded, 38.5 feet (present datum) at 7 a. m. November 23, 1909 (discharge, estimated from extension of rating curve, 163,000 second-feet); minimum stage recorded, 0.10 foot September 17 to October 24, 1915 (discharge, 950 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—Practically none.

REGULATION.—Practically none.

ACCURACY.—Stage-discharge relation practically permanent during year. Rating curve well defined. Gage read twice a day to tenths. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of Umpqua River near Elkton, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec. Ft.*			*Feet.*	*Sec.-Ft.*
Feb. 3	M. S. Kelley[1]	4.30	7,280	Feb. 26	M. S. Kelley[1]	8.75	22,000
4	do	5.25	10,000	27	do	7.80	18,000
5	do	6.14	12,400	Mar. 6	do	10.25	25,900
13	do	7.00	14,800	Aug. 30 and 31	F. F. Henshaw	0.56	1,370

[1] Employee of J. G. Kelley, consulting engineer, Portland, Oreg.

Digitized by Google

Daily discharge, in second-feet, of Umpqua River near Elkton, Oreg., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,140	1,450	12,600	9,100	9,600	12,600	20,600	13,200	11,400	7,220	1,560	1,240
2	1,140	1,290	10,200	11,700	8,120	11,700	20,200	16,000	10,800	6,800	1,670	1,240
3	1,140	1,240	7,660	14,700	7,660	10,500	24,400	13,800	10,200	7,220	1,560	1,240
4	1,140	1,560	6,800	21,000	9,900	9,600	19,600	12,000	9,350	6,800	1,560	1,240
5	1,140	1,670	8,600	15,000	12,600	15,700	17,100	10,800	8,120	6,400	1,670	1,240
6	1,140	1,560	10,800	25,800	12,000	25,800	22,000	11,700	8,120	6,010	1,560	1,240
7	1,140	1,780	12,000	24,800	12,600	19,900	21,600	18,500	9,100	5,630	1,450	1,190
8	1,140	3,910	10,800	18,200	12,000	16,400	36,300	18,500	10,800	5,080	1,450	1,140
9	1,140	4,900	9,350	16,000	11,100	16,400	27,600	17,400	11,400	4,900	1,450	1,140
10	1,140	3,140	8,600	14,100	10,200	13,800	23,000	16,400	10,800	5,260	1,450	1,240
11	1,140	2,690	8,120	12,000	10,800	13,200	23,000	15,700	10,200	4,900	1,450	1,340
12	1,140	2,280	7,660	10,200	15,700	11,400	33,100	15,000	9,600	4,560	1,450	1,340
13	1,140	1,900	6,800	6,800	15,700	10,800	26,600	15,000	8,850	4,230	1,340	1,340
14	1,140	1,670	6,400	7,220	13,500	10,800	21,300	14,400	9,120	3,910	1,290	1,240
15	1,140	1,450	6,400	7,890	10,200	9,600	19,200	13,800	10,800	3,590	1,240	1,340
16	1,140	1,450	6,400	7,660	9,600	8,600	17,100	12,600	10,200	2,990	1,190	1,340
17	1,140	1,450	6,600	7,220	10,800	8,120	15,000	13,800	9,600	2,690	1,190	1,290
18	1,140	1,670	8,600	6,400	9,900	8,120	13,800	17,800	9,100	2,410	1,190	1,240
19	1,140	1,670	10,800	6,010	9,100	8,600	12,000	17,100	8,600	2,410	1,240	1,240
20	1,140	1,560	13,500	5,630	11,400	9,100	11,400	15,000	9,350	2,690	1,340	1,240
21	1,140	1,560	15,000	5,260	10,800	9,350	14,400	13,800	9,600	2,410	1,240	1,240
22	1,140	1,560	14,400	4,900	10,800	10,800	18,200	12,300	9,100	2,280	1,240	1,240
23	1,140	1,670	15,000	4,560	11,100	11,100	17,400	17,400	8,600	2,150	1,240	1,240
24	1,140	1,670	13,800	4,230	10,200	20,200	18,500	10,800	8,120	1,900	1,290	1,240
25	1,140	1,670	12,300	3,910	15,700	38,700	20,200	10,200	7,660	2,150	1,450	1,240
26	1,140	6,800	10,800	3,750	20,600	26,200	19,900	9,350	7,220	1,900	1,450	1,240
27	1,140	13,200	9,100	3,750	17,800	24,400	18,200	8,600	6,800	1,900	1,450	1,240
28	1,140	12,000	8,120	4,560	14,400	37,900	16,400	10,200	7,220	1,900	1,340	1,240
29	1,140	12,600	7,660	14,400	.....	33,900	15,000	13,500	7,890	1,670	1,450	1,240
30	1,140	15,400	7,010	15,000	.....	31,100	12,600	13,200	7,660	1,670	1,450	1,240
31	1,290	.....	7,440	12,000	.....	26,200	.....	12,000	.....	1,670	1,290	.....

Monthly discharge of Umpqua River near Elkton, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 3,680 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	1,290	1,140	1,140	.310	.36	70,100
November	15,400	1,240	3,610	.981	1.09	215,000
December	15,000	6,400	9,660	2.62	3.02	594,000
January	25,800	3,750	10,400	2.83	3.26	640,000
February	20,600	7,660	12,100	3.29	3.43	672,000
March	38,700	8,120	16,800	4.57	5.27	1,030,000
April	36,300	11,400	19,900	5.41	6.04	1,180,000
May	18,500	8,600	13,700	3.72	4.29	842,000
June	11,400	6,800	9,180	2.49	2.78	546,000
July	7,220	1,670	3,780	1.03	1.19	232,000
August	1,670	1,190	1,390	.378	.44	85,500
September	1,340	1,140	1,250	.340	.38	74,400
The year	38,700	1,140	8,550	2.32	31.55	6,180,000

NORTH UMPQUA RIVER AT TOKETEE FALLS, OREG.

LOCATION.—In T. 26 S., R. 5 E. (unsurveyed), one-eighth mile below mouth of Clearwater River, half a mile above Toketee Falls, 52 miles by trail east of Hoaglin post office, and 76 miles east of Roseburg, Douglas County.

DRAINAGE AREA.—337 square miles (measured on topographic map).

Digitized by Google

RECORDS AVAILABLE.—February 26, 1908, to July 20, 1909; December 19, 1914, to November 19, 1917, with missing periods. Station discontinued.

GAGE.—Stevens continuous water-stage recorder on left bank. Readings for 1908 and 1909 were made on staff gage at same datum.

DISCHARGE MEASUREMENTS.—Made from cable about 75 feet below gage; good measuring section.

CHANNEL AND CONTROL.—Boulders, rock, and heavy gravel; fairly smooth; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 4.18 feet sometime between January 13 and August 21; minimum stage from water-stage recorder, 1.65 feet October 8 and 9 (discharge 705 second-feet).

1908–9 and 1915–1917: Maximum stage recorded, 4.33 feet January 21, 1909; minimum stage recorded, 1.38 feet October 8 to 12, and 27 to 30, 1915 (discharge 582 second-feet).

ICE.—Stage-discharge relation unaffected, as much of the water comes from springs

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation considered practically permanent. Rating curve fairly well defined below 1,200 second-feet; not defined above this. Operation of recorder fairly satisfactory; gage heights somewhat uncertain at times owing to the infrequent inspection of gage. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting the recorder graph. Low-water records good.

The following discharge measurement was made by R. C. Briggs:
August 29, 1917: Gage height, 1.90 feet; discharge, 851 second-feet.

Daily discharge, in second-feet, of North Umpqua River at Toketee Falls, Oreg., for the years ending Sept. 30, 1915-1917.

Day.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Aug.	Sept.
1914–15.								
1	.....	705	820	790	945	880	.....	590
2	.....	705	820	790	1,020	880	.....	590
3	.....	705	820	790	1,080	880	.....	590
4	.....	705	820	790	1,050	850	.....	590
5	.....	705	790	790	1,020	850	.....	590
6	.....	705	790	790	980	820	.....	590
7	.....	730	790	790	1,020	820	.....	612
8	.....	760	760	790	980	820	.....	590
9	.....	730	760	760	945	850	.....	590
10	.....	730	760	760	945	880	.....	590
11	.....	730	760	760	980	880	.....	612
12	.....	730	790	790	1,020	880	.....	612
13	.....	790	790	820	1,050	910	635	612
14	.....	790	790	880	1,020	945	635	612
15	.....	760	790	880	980	910	635	612
16	.....	760	790	880	980	880	612	612
17	.....	760	790	910	1,020	910	612	612
18	680	760	790	910	1,020	1,020	612	612
19	680	730	790	910	1,050	1,050	612	590
20	.....	730	790	910	1,050	1,020	612	590
21	680	730	790	945	1,050	1,020	612	590
22	680	730	790	980	1,020	1,020	612	590
23	680	730	790	1,020	980	980	612	590
24	680	730	.....	1,020	945	1,120	612	590
25	680	730	.....	980	910	1,050	612	590
26	705	880	.....	945	910	1,080	612	590
27	680	910	.....	910	910	1,080	612	590
28	680	910	.....	910	910	1,120	612	590
29	680	880	.....	910	945	1,080	612	590
30	680	850	.....	910	910	1,050	590	590
31	705	820	.....	910	.....	1,020	590	.....

Digitized by Google

Daily discharge, in second-feet, of North Umpqua River at Toketee Falls, Oreg., for the years ending Sept. 30, 1915–1917—Continued.

Day.	Oct.	Nov.	Dec.	Jan.	July.	Aug.	Sept.
1915–16.							
1	590	590	.....	880	.....	910	790
2	590	590	.....	.....	.....	910	790
3	590	590	.....	.....	.....	910	820
4	590	590	.....	820	.....	880	790
5	586	590	.....	760	.....	880	790
6	586	590	.....	760	.....	850	790
7	586	590	.....	.....	.....	850	790
8	582	612	.....	760	.....	850	790
9	582	590	.....	760	.....	850	790
10	582	590	.....	760	.....	850	790
11	582	612	980	.....	.....	850	790
12	582	612	910	730	.....	850	790
13	590	590	910	730	.....	850	760
14	590	612	.....	730	.....	850	760
15	590	658	.....	730	.....	850	760
16	590	658	.....	730	.....	850	760
17	586	705	820	.....	.....	850	760
18	586	760	820	705	.....	850	760
19	582	680	790	705	.....	820	760
20	586	760	859	705	.....	820	760
21	582	760	1,020	705	1,120	820	760
22	582	.....	.....	.....	1,080	820	760
23	635	.....	.....	820	1,020	820	760
24	590	.....	.....	850	980	820	760
25	590	.....	.....	820	945	820	760
26	590	.....	.....	.....	910	820	760
27	582	.....	.....	.....	910	820	760
28	582	.....	.....	760	910	820	760
29	582	.....	.....	730	910	820	760
30	582	.....	980	.....	910	790	760
31	586	.....	945	.....	910	790	.....

Day.	Oct.	Nov.	Dec.	Jan.	Aug.	Sept.	Day.	Oct.	Nov.	Dec.	Jan.	Aug.	Sept.
1916–17.							1916–17.						
1	730	730	760	730	.....	850	16	730	730	730	.....	.....	820
2	730	730	760	730	.....	850	17	730	730	730	.....	.....	790
3	730	730	730	730	.....	820	18	730	730	730	.....	.....	790
4	730	760	730	790	.....	820	19	730	730	730	.....	.....	820
5	730	730	730	880	.....	820	20	730	730	760	.....	.....	790
6	705	760	730	850	.....	820	21	730	730	760	.....	850	790
7	705	760	730	820	.....	820	22	730	730	730	.....	850	790
8	705	760	730	820	.....	820	23	730	730	730	.....	850	790
9	705	760	730	820	.....	820	24	730	760	730	.....	850	790
10	705	730	730	820	.....	820	25	730	750	730	.....	850	790
11	705	730	730	790	.....	820	26	730	790	730	.....	850	790
12	730	730	730	790	.....	820	27	730	910	730	.....	850	790
13	730	730	730	760	.....	820	28	730	790	730	.....	850	790
14	730	730	730	.....	.....	820	29	730	760	730	.....	850	790
15	730	730	730	.....	.....	820	30	730	760	730	.....	850	790
							31	730	.....	730	.....	850	.....

NOTE.—No record June 1 to Aug. 12, Nov. 22–24, Nov. 26 to Dec. 10, Dec. 14–16 and 22–29, 1915; Jan. 2, 3, 7, 11, 17, 22, 26, 27, and Jan. 30 to Mar. 22 and June 14 to July 20, 1916; Jan. 14 to Aug. 20, 1917. Discharge exceeded 1,200 second-feet Nov. 25, 1915, March 23 to June 13, 1916, and probably for considerable periods not covered by records. Discharge Oct. 1, 1917, 790 second-feet; Oct. 8, 1917, 760 second-feet; Oct. 30, 1917, 705 second-feet; Nov. 6, 1917, 760 second-feet; and Nov. 19, 1917, 730 second-feet.

Digitized by Google

Monthly discharge of North Umpqua River at Toketee Falls, Oreg., for 1914-1917.

Month.	Discharge in second-feet.			Run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
1914.				
December 19-31	705	680	684	17,600
1915.				
January	910	705	762	46,900
February	820	760	790	43,900
March	1,020	760	869	53,400
April	1,080	910	988	58,800
May	1,120	820	953	58,600
August 13-31	635	590	613	23,100
September	612	590	597	35,500
October	635	582	587	36,100
November 1-21	760	590	635	26,400
1916.				
July 21-31	1,120	910	964	21,000
August	910	790	843	51,800
September	820	760	773	46,000
October	730	705	725	44,600
November	910	730	752	44,700
December	760	730	734	45,100
1917.				
January 1-13	880	730	795	20,500
August 21-31	850	850	850	18,500
September	850	790	809	48,100

NORTH UMPQUA RIVER NEAR GLIDE, OREG.

LOCATION.—In SW. ¼ sec. 13, T. 26 S., R. 4 W. at Hughes ferry, about 2 miles below Glide, Douglas County, just off main road to Roseburg.

DRAINAGE AREA.—1,210 square miles (measured on topographic and Forest Service maps).

RECORDS AVAILABLE.—September 1, 1915, to September 30, 1917.

GAGE.—Vertical staff on left bank just below ferry landing. Gage reader, J. H. Hayes.

DISCHARGE MEASUREMENTS.—Made from ferry up to a stage of about 6 feet; excellent section. Flood measurements have been made from the bridge at Winchester, about 20 miles downstream, and the inflow, estimated from measurements of Oak Creek, deducted.

CHANNEL AND CONTROL.—Practically permanent; control is of solid rock.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.4 feet at 6 p. m. April 11 (discharge, 18,100 second-feet); minimum stage recorded, 0.22 foot October 19 to 21 (discharge, 866 second-feet).

1915-1917: Maximum stage recorded, 12.8 feet at 3 p. m., November 25, 1915, (discharge, 42 000 second-feet); minimum stage recorded 0.05 foot October 1, 2, 7, to 13, and 18 to 22, 1915 (discharge, 750 second-feet).

Maximum stage in many years occurred during night of November 22, 1909; gage height 22 feet as determined by leveling to well-defined high-water marks on September 1, 1917 (discharge, estimated from extension of rating curve, 90 000 second-feet).

ICE.—Never any ice here.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation, practically permanent. Rating curve, well defined below 10,000 second-feet and fairly well defined above. Gage read to quarter tenths once or twice daily except for days given in footnote to table of daily discharge. Daily discharge ascertained by applying mean daily gage height to rating table. Records excellent.

Digitized by Google

Discharge measurements of North Umpqua River near Glide, Oreg., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
June 15	C. L. Batchelder	3.45	6,110
Sept. 1	F. F. Henshaw	.50	1,120

Daily discharge, in second-feet, of North Umpqua River near Glide, Oreg., for the year ending Sept. 30 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	930	1,070	2,300	2,000	2,620	3,270	5,700	.....	6,350	3,610	1,450	1,120
2	930	1,020	3,610	5,300	2,620	3,100	8,850	.....	5,900	3,610	1,450	1,120
3	930	1,120	3,780	7,100	3,960	2,940	7,350	.....	5,300	3,610	1,390	1,070
4	980	1,580	4,140	4,900	5,500	3,100	6,100	.....	4,700	3,610	1,390	1,070
5	930	1,580	4,110	12,500	5,300	7,350	9,400	.....	4,700	3,610	1,390	1,070
6	930	2,150	3,960	9,400	5,700	6,350	10,600	9,400	5,300	3,440	1,330	1,070
7	930	2,300	2,940	6,600	5,900	4,900	13,900	10,600	5,900	3,270	1,330	1,070
8	930	1,720	2,460	5,100	5,300	4,510	16,700	10,300	6,850	3,100	1,330	1,120
9	930	1,450	2,940	4,320	4,900	4,320	11,800	10,300	7,850	2,940	1,280	1,070
10	930	1,450	2,620	3,960	4,700	3,780	6,850	9,700	6,850	2,940	1,280	1,120
11	930	1,450	2,300	3,960	6,100	3,440	17,400	9,400	5,500	2,780	1,280	1,120
12	930	1,220	2,150	3,780	8,100	3,100	15,300	8,850	4,900	2,620	1,280	1,170
13	930	1,120	2,000	3,270	6,350	3,100	10,000	8,350	4,900	2,460	1,280	1,170
14	930	1,070	2,000	2,940	5,100	2,940	8,350	8,600	5,100	2,460	1,280	1,120
15	930	1,070	2,000	2,620	5,100	2,780	7,100	7,600	5,900	2,460	1,280	1,070
16	930	1,020	2,150	2,300	4,510	2,780	5,900	7,350	6,600	2,300	1,220	1,070
17	930	1,020	2,150	2,150	5,500	2,780	5,300	8,850	6,350	2,300	1,220	1,070
18	930	1,120	2,300	2,150	4,510	2,940	4,700	8,600	6,100	2,150	1,220	1,070
19	890	1,330	4,510	2,150	3,960	3,100	4,700	7,350	5,900	2,000	1,220	1,070
20	930	1,220	8,350	2,000	3,610	3,100	4,510	7,100	5,500	2,000	1,220	1,070
21	890	1,120	6,600	2,000	3,270	4,510	8,850	6,850	5,100	1,860	1,170	1,070
22	930	1,120	5,500	2,000	3,100	3,780	7,850	6,350	5,100	1,790	1,170	1,070
23	890	1,120	3,960	2,000	2,940	3,780	7,850	5,700	4,510	1,720	1,170	1,070
24	890	1,120	3,270	1,860	2,940	10,300	10,900	5,300	4,320	1,650	1,170	1,120
25	890	1,720	2,780	1,860	5,900	11,200	12,500	5,100	4,140	1,650	1,170	1,070
26	890	7,850	2,460	2,000	4,700	6,600	12,200	4,700	4,140	1,580	1,170	1,070
27	890	5,300	2,300	2,150	3,960	11,800	11,800	4,700	4,140	1,580	1,170	1,070
28	930	6,350	2,150	8,100	3,610	14,200	10,300	5,900	3,960	1,520	1,170	1,070
29	930	3,780	2,000	5,100	.....	14,200	.....	6,850	3,610	1,520	1,170	1,070
30	1,020	2,780	1,860	3,960	.....	9,100	.....	6,350	3,610	1,520	1,170	1,020
31	1,020	.....	1,860	3,100	.....	6,850	.....	6,350	.....	1,450	1,120	.....

NOTE.—Discharge estimated April 29 and 30, 9,000 and 7,500 second-feet, respectively. Mean discharge estimated May 1-5, 8,000 second-feet.

Monthly discharge of North Umpqua River near Glide, Oreg., for the year ending Sept. 30, 1917.

[Drainage area, 1,210 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	1,020	890	927	0.766	0.88	57,000
November	7,850	1,020	1,980	1.64	1.83	118,000
December	8,350	1,860	3,150	2.60	3.00	194,000
January	12,500	1,860	3,960	3.27	3.77	243,000
February	8,100	2,620	4,630	3.83	3.99	257,000
March	14,200	2,780	5,480	4.53	5.22	337,000
April	17,400	4,510	9,310	7.69	8.58	554,000
May	10,600	4,700	7,630	6.31	7.28	469,000
June	7,850	3,610	5,300	4.38	4.89	315,000
July	3,610	1,450	2,420	2.00	2.31	149,000
August	1,450	1,120	1,260	1.04	1.20	77,500
September	1,170	1,020	1,090	.901	1.01	64,900
The year	17,400	890	3,920	3.24	43.96	2,840,000

Digitized by Google

MILL CREEK NEAR ASH, OREG.

LOCATION.—In sec. 2, T. 23 S., R. 10 W., three-quarters of a mile below outlet of Loon Lake, 5 miles northwest of Ash post office, and about 12 miles south of Scottsburg, Douglas County.

DRAINAGE AREA.—90 square miles (measured on maps prepared by J. G. Kelley).

RECORDS AVAILABLE.—May 29, 1907, to September 30, 1912; April 20, 1915, to November 12, 1917, when station was discontinued.

GAGE.—Stevens water-stage recorder on right bank; inspected by Richard Peterson. Vertical staff on lake was read 1907 to 1912, and for comparison in 1915 and 1916.

DISCHARGE MEASUREMENTS.—Made from cable at gage or at low stages by wading.

CHANNEL AND CONTROL.—Channel, gravel; control of boulders and clay about 85 feet downstream from gage. Rock channel at lake outlet forms control for lake gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, about 6.60 feet at 5 a. m. March 25 (discharge, 3,180 second-feet); minimum stage uncertain as water-stage recorder was not working (discharge, 3.7 second-feet or less).

1907–1912 and 1915–1917: Maximum stage recorded on lake gage, 21.4 feet November 23, 1909 (discharge, 10,000 second-feet); minimum stage recorded, 2.1 feet September 13 to 20 and September 25 to October 2, 1910 (discharge, 1.5 second-feet).

ICE.—Stage-discharge relation unaffected by ice.

DIVERSIONS.—None.

REGULATION.—Some fluctuation at low water due to effect of wind on lake.

ACCURACY.—Stage-discharge relation assumed to be practically permanent, although no discharge measurements were made after the 1917 high water. Rating curve well defined. Operation of water-stage recorder satisfactory January to June; unsatisfactory for rest of year. Gage heights taken from Loon Lake gage for December, except 8 to 14 and 29 to 31. Daily discharge ascertained by applying to rating table the mean daily gage height determined by inspecting gage-height graph or, for days of considerable fluctuation, by averaging discharge obtained by applying to rating table the mean gage heights for bihourly periods. Records good, January to June; fair for rest of period.

COOPERATION.—Gage-height and discharge-measurement records furnished by J. G. Kelley, consulting engineer, Portland, Oreg.

Discharge measurements of Mill Creek near Ash, Oreg., during the period Oct. 1, 1916, to Nov. 12, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1916.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Oct. 15	H. V. Eva	0.33	4.1	Nov. 6	Kelley and Eva	1.48	155
28	do	.31	4.0	17	H. V. Eva	.85	39.8
Nov. 2	do	.50	11.4				

Digitized by Google

Daily discharge, in second-feet, of Mill Creek near Ash, Oreg., for the period Oct. 1, 1916, to Nov. 12, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	8.4	350	330	700	382	900	210	90	.....	5.0	4.0	.....	2.2
2	.....	11	310	455	605	348	900	198	85	.....	4.7	4.0	.....	2.2
3	.....	14	310	960	700	315	1,080	185	80	.....	4.7	4.0	.....	2.2
4	.....	31	480	1,020	800	330	900	172	76	.....	5.0	4.0	.....	2.3
5	.....	[a] 96	750	1,020	700	700	750	160	74	.....	4.7	4.0	.....	2.3
6	.....	160	900	1,260	628	1,020	650	185	70	.....	4.4	4.0	.....	2.6
7	.....	285	820	1,200	538	960	[a] 605	210	68	.....	4.4	4.0	.....	2.8
8	.....	240	750	900	475	800	560	225	65	.....	4.0	4.7	.....	3.4
9	.....	172	900	700	400	800	560	210	63	.....	.....	4.7	.....	3.7
10	.....	127	960	538	365	750	515	198	62	.....	.....	4.4	.....	4.0
11	.....	104	800	435	348	700	560	185	59	15	.....	4.7	.....	4.7
12	.....	85	605	365	382	582	650	172	56	15	.....	4.7	.....	7.5
13	.....	[a] 73	475	315	365	560	700	160	52	15	.....	4.4	2.5	.....
14	.....	[a] 62	382	270	330	560	700	155	46	14	.....	4.0	2.5	.....
15	5.0	50	326	240	300	538	700	150	39	13	.....	4.0	2.5	.....
16	5.0	46	270	225	270	475	628	155	35	13	.....	4.0	2.3	.....
17	4.7	42	235	198	255	435	560	153	34	12	.....	4.0	2.2	.....
18	4.7	39	200	185	225	418	475	198	31	11	.....	4.0	2.2	.....
19	4.0	36	223	172	240	435	435	240	28	11	.....	.....	2.1	.....
20	3.7	34	247	172	300	455	400	225	24	9.8	.....	.....	2.2	.....
21	3.7	32	270	185	348	605	538	210	22	9.3	.....	.....	2.2	.....
22	3.7	30	620	198	400	800	582	185	22	8.8	.....	.....	2.2	.....
23	3.7	29	588	198	435	1,020	495	172	22	7.5	.....	.....	2.1	.....
24	[a] 3.8	29	556	198	418	1,810	435	153	20	7.5	.....	.....	2.1	.....
25	[a] 4.0	57	525	198	382	2,860	348	143	20	7.5	.....	.....	2.3	.....
26	[a] 4.1	210	494	198	382	1,880	285	134	18	6.8	.....	.....	2.3	.....
27	[a] 4.3	400	462	225	400	1,320	240	125	18	6.8	.....	.....	2.3	.....
28	4.4	628	430	582	418	1,200	210	116	17	6.8	.....	.....	2.1	.....
29	5.4	560	435	900	.....	1,200	198	110	18	6.8	4.0	.....	2.1	.....
30	5.8	348	400	1,020	.....	1,260	210	104	18	6.8	4.0	.....	2.1	.....
31	7.2	.....	365	900	.....	1,080	.....	96	.....	5.8	4.0	.....	2.2	.....

[a] Discharge interpolated.

NOTE.—Discharge estimated as follows: Oct. 1–14, 6 second-feet; July 1–10, 16 second-feet; Aug. 9–28, 4 second-feet; Sept. 19–30, 3.5 second-feet; Oct. 1–12, 3.0 second-feet. Loon Kake gage read Dec. 1–7, 16, 18, 21, 22, and 28; discharge Dec. 1–7 and 15–28 beced on these readings.

Monthly discharge of Mill Creek near Ash, Oreg., for the period Oct. 1, 1916, to Nov. 12, 1917.

[Drainage area, 90 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	7.2	3.7	5.20	0.058	0.07	320
November	628	8.4	135	1.50	1.67	8,030
December	960	200	498	5.53	6.38	30,600
January	1,260	172	508	5.64	6.50	31,200
February	800	225	432	4.80	5.00	24,000
March	2,860	315	858	9.53	11.00	52,800
April	1,080	198	559	6.21	6.93	33,300
May	240	96	171	1.90	2.19	10,500
June	90	17	44.4	.493	.55	2,640
July	.....	5.8	11.9	.132	.15	732
August	5.0	.....	4.16	.046	.05	256
September	4.7	.....	3.92	.044	.05	233
October	.....	2.1	2.53	.281	.32	156
November 1–12	7.5	2.2	3.32	.369	.16	79
The year	2,860	.....	269	2.99	40.54	195,000

Digitized by Google

MISCELLANEOUS DISCHARGE MEASUREMENTS.

Records of measurements of the flow of streams at points other than those at which gaging stations were maintained are presented in the following tables:

Miscellaneous discharge measurements in lower Columbia River basin and Pacific slope basins in Oregon during the year ending Sept. 30, 1917.

Walla Walla River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Nov. 2	Mill Creek	Walla Walla River	Above city of Walla Walla diversion dam, 12 miles east of Walla Walla, Wash.		49.9
Mar. 9	do	do	do		83.5
Apr. 10	do	do	do		398
June 30	do	do	do		134
Sept. 15	do	do	do		57.6

Umatilla River basin.

May 3	Umatilla	Columbia River	Pendleton, Oreg	4.65	1,620
June 29	do	do	Below Furnish reservoir, Oreg	1.71	417
July 3	do	do	do	1.50	328
14	do	do	do	1.21	220
27	do	do	do	.97	145
Aug. 6	do	do	do	.81	102
9	do	do	do	.74	85

John Day River basin.

Oct. 31	Prairie Power Co.'s flume.	Diverts from John Day River.	Prairie City, Oreg		44.3
31	Strawberry Creek	John Day River	100 yards below source of creek, in sec. 30, T. 14 S., R. 34 E.		3.2
Nov. 1	North Fork of John Day River.	do	Highway bridge, 1 mile from Dale, Oreg.		71

Deschutes River basin.

Oct. 14	Deschutes River	Columbia River	Pringle Falls, SW. ¼ sec. 23, T. 21 S., R. 9 E., Oreg.	1.28	1,070
June 3	do	do	do	1.28	1,040
Aug 20	do	do	do	1.32	987
June 5	Marks Creek	Ochoco Creek	Sear's ranch, near mouth	3.73	40.0
5	Mill Creek	do	Sec. 25, T. 13 S., R. 17 E., about 200 feet above 1916 gage.	2.10	66
Mar. 28	McKay Creek	do	Sec. 4, T. 14 S., R. 16 E	.70	27.8
June 6	do	do	do	.40	23.0
Aug. 13	do	do	do		.8
1916. Oct. 17	Jack Creek	Metolius River	SE. ¼ sec. 28, T. 12 S., R. 9 E	1.09	75
May 30	do	do	do	.73	47.1
Aug 1	do	do	do	.85	[a] 58
11	do	do	do	.80	[a] 54
18	do	do	do	.80	[a] 54
Oct. 16	do	do	do	.96	69
1916. Oct. 17	Canyon Creek	do	NW. ¼ sec. 27, T. 12 S., R. 9 E	1.93	67
1917. May 30	do	do	do	2.32	132
Aug 1	do	do	do	2.1	[a] 95
11	do	do	do	2.0	[a] 80
18	do	do	do	1.98	[a] 77
Oct. 16	do	do	do	1.90	68.6
May 22	Clear Creek	White River	SW. ¼ sec. 8, T. 5 S., R. 10 E	1.73	172

[a] Discharge computed from gage readings.

Digitized by Google

Miscellaneous discharge measurements in lower Columbia River basin and Pacific slope basins in Oregon during the year ending Sept. 30, 1917—Continued.

Klickitat River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Oct. 24	Klickitat River	Columbia River	Caldwell Prairie, sec. 29, T. 9 N., R. 13 E., Wash.	0.72	24.1
25	Diamond Fork	Klickitat River	Mouth, sec. 3, T. 10 N., R. 13 E.	.08	37.5
Apr. 5	Little Muddy Creek	West Fork	Elevation 4,650 feet		2.6
5	Crawford Creek	Little Muddy Creek	Elevation about 4,700 feet		.23
6	Trapper Creek	do	Elevation about 4,700 feet, below forks, ½ mile above Yakima Indian Reservation boundary.		.81
6	Unnamed creek north of Little Muddy Creek.	Trapper Creek	Elevation 4,650 feet		.23
7	Cunningham Creek	Klickitat River	do		Dry
7	Big Muddy Creek	do	1,000 feet above Hellroaring Creek.		35.1
7	Hellroaring Creek	Big Muddy Creek	400 feet above mouth		8.8
8	Cougar Creek	do	Mouth		[a] .5
Mar. 31	Dairy Creek	Klickitat River	Road crossing, sec. 10, T. 7 N., R. 12 E.		[a] 1.0

[a] Estimated.

Gorton Creek basin.

Aug. 25	Gorton Creek	Columbia River	Above Oregon-Washington Railroad & Navigation Co.'s intake near Wyeth, Oreg., sec. 1, T. 2 N., R. 8 E.	0.95	2.6

Willamette River basin.

June 13	North Fork of Middle Fork of Willamette River.	Middle Fork of Willamette River.	Former gaging station near Oakridge, Oreg., SE. ¼ sec. 7, T. 21 S., R. 3 E.	3.65	1,500

Youngs River basin.

Aug. 14	Youngs River	Columbia River	Below falls near Astoria, Oreg.		13.8

Rogue River basin.

Oct. 3	Mill Creek	Rogue River	Former gaging station near Prospect, Oreg.	2.95	49.6
3	Red Blanket Creek	Middle Fork of Rogue River.	Old road crossing near Prospect, Oreg.		75
June 17	North Fork of Little Butte Creek.	Little Butte Creek	Former gaging station above city intake near Lake Creek, Oreg., in sec. 25, R. 2 E., T. 36 S.	2.15	209
July 10	do	do	do	1.85	113
Sept. 4	do	do	do	1.81	85.3
Sept. 5	Paley ditch	Diverts from North Fork Little Butte Creek.	Sec. 22, T. 36 S., R. 2 E. at intake of Rogue River Valley canal.		3.0
Apr. 17	Emigrant Creek	Bear Creek	Sec. 34, T. 39 S., R. 2 E., at Klamath Falls road crossing.		62.2
June 9	do	do	do		24.3
Apr. 20	Walker Creek	Emigrant Creek	Bridge just above mouth in sec. 12, T. 39 S., R. 1 E.		49.3
June 9	do	do	do		17.7
May 3	McDonald Creek	Little Applegate River.	1 mile above mouth in sec, 10, T. 40 S., R. 1 W.		13.6
31	do	do	do	1.50	29.9
June 22	do	do	do	1.56	34.6
July 13	do	do	do	0.82	10.4
June 13	Sterling ditch	From Glade Creek	Sec. 30, T. 39 S., R. 1 W.		33.0
July 14	do	do	do		29.8
Apr. 20	do	do	do	2.0	15.1
May 30	Neil Creek	Bear Creek	Sec. 12 T. 39 S., R. 1 E., at Dead Indian road crossing.	2.2	32.0

Digitized by Google

Miscellaneous discharge measurements in lower Columbia River basin and Pacific slope basins in Oregon during the year ending Sept. 30, 1917—Continued.

Umpqua River basin.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Aug. 27	Lake Creek	North Umpqua River.	SW. ¼ sec. 30, T. 27 S., R. 6 E., at outlet of Diamond Lake.		31.8
27	Thielsen Creek	Lake Creek	Trail crossing at elevation about 4,700 feet.		4.5
28	Clearwater River	North Umpqua River.	Elevation 3,700 feet		172
29	do	do	Elevation about 2,400 feet near mouth.		175
28	Watson Creek	Clearwater River	Trail crossing at elevation 3,400 feet.		5.9

Siuslaw River basin.

Oct. 23	Siuslaw River	Pacific Ocean	Railroad bridge at Austa station.		59.3

Digitized by Google

INDEX.

Page.

Accuracy of data and results of computation, degrees of..... 10-11
Acknowledgments for aid..... 11
Acre-foot, definition of..... 8
Albany, Oreg., Willamette River at.....99-100
Allingham ranger station, Oreg., Metolius River at..... 59-60
Amboy, Wash., Lewis River near..... 108-109
Antelope, Oreg., Trout Creek near..... 63-64
Appropriations, record of..... 7
Arnold canal near Bend, Oreg..... 39-41
Ash, Oreg., Mill Creek near..... 142-143
Astoria, Oreg., Youngs River near..... 119,145
Austa, Oreg., Siuslaw River at..... 146
Authorization of work..... 7

Bear Creek at Medford, Oreg..... 131-133
Bend, Oreg., Arnold canal near..... 39-41
Central Oregon canal near..... 41-42
Columbia Southern canal near..... 50
Crater Creek near..... 50
Deschutes River below..... 32-34
North canal near..... 44-45
Pilot Butte canal near..... 42-44
Swalley canal near..... 46-47
Tumalo Creek near..... 47-50
Tumalo feed canal near..... 50-51
Big Muddy Creek near Glenwood, Wash.... 70-71
near Klickitat River, Wash..... 145
Brightwood, Oreg., Lost Creek near..... 91-93
Brownsboro, Oreg., Rogue River Valley canal near..... 130-131
Bull Run River near Bull Run, Oreg 94-96

Cable Creek near Ukiah, Oreg..... 28
Caldwell Prairie, Wash., Klickitat River at.. 145
California-Oregon Power Co.'s flume near Prospect, Oreg..... 124-125
Camas Creek near Ukiah, Oreg..... 27
Canyon Creek near Metolius River, Oreg.... 144
Cazadero, Oreg., Clackamas River near.... 105-106
Oak Grove Fork of Clackamas River near.106-107
Central Oregon canal near Bend, Oreg..... 41-42
Clackamas River near Cazadero, Oreg..... 105-106
Oak Grove Fork of, near Cazadero, Oreg. 106-107
Clear Creek near White River, Oreg..... 144
Clear Fork near Lewis, Wash..... 116-117
Clearwater River near North Umpqua River, Oreg..... 146
Columbia River at The Dalles, Oreg..... 12-13
Columbia Southern canal near Bend, Oreg.. 50
Computation, accuracy of results of..... 10-11
Control, definition of..... 8
Cooperation, record of..... 11
Coquille River, South Fork of, at Powers, Oreg..... 134-135

Page.

Cougar Creek at mouth, on Big Muddy Creek, Wash..... 145
Cowlitz River at Lewis, Wash..... 112-114
at Mossy Rock, Wash..... 114-115
Cowlitz River basin, gaging-station records in..... 111-118
Crane Prairie, near Lapine, Oreg., Deschutes River at..... 29-30
Crater Creek near Bend, Oreg..... 50
Crawford Creek near Little Muddy Creek, Wash..... 145
Cunningham Creek near Klickitat River, Wash..... 145
Current meters, Price, plate showing..... 8

Dairy Creek near Klickitat River, Wash..... 145
Dale, Oreg., Desolation Creek near..... 25-26
North Fork of John Day River near..... 144
Dalles, The, Oreg., Columbia River at..... 12-13
Data, accuracy of..... 10-11
explanation of..... 9-10
Dead Indian Creek near Lilyglen, Oreg.... 127-129
Deadwood, Oreg., South Fork of Little Butte Creek near..... 125
Dee, Oreg., East Fork of Hood River near... 80-81
Hood River at..... 72-73
Definition of terms..... 8
Deschutes River at Crane Prairie, near Lapine, Oreg..... 29-30
at Mecca, Oreg..... 34-35
at Moody, near Biggs, Oreg..... 36-38
at Pringle Falls, Oreg..... 144
below Bend, Oreg..... 32-34
near Lapine, Oreg..... 29-32
Deschutes River basin, gaging-station records in..... 29-67
Desolation Creek near Dale, Oreg..... 25-26
Diamond Fork at mouth on Klickitat River, Wash..... 145
Dickinson, W. E., work of..... 12

Eagle Point, Oreg., Little Butte Creek above..... 126-127
East Fork at Morson intake, near Lapine, Oreg..... 38-39
East Fork Irrigation District canal near Mount Hood, Oreg..... 81-82
Elkton, Oreg., Umpqua River near..... 136-137
Elliott ditch near Prineville, Oreg..... 58-59
Elliott ranch, near Prineville, Oreg., Ochoco Creek at..... 55-57
Emigrant Creek near Bear Creek, Oreg..... 145

First Creek near Sisters, Oreg..... 62-63
Friez water-stage recorder, plate showing.... 9

Digitized by Google

Page.
Furnish reservoir near Yoakum, Oreg., Umatilla River near..... 17-21, 144

Gaging station, typical, plate showing..... 8
Glenwood, Wash., Big Muddy Creek near... 70-71
Klickitat River near..... 68-69
Glide, Oreg., North Umpqua River near.... 140-141
Gorton Creek near Wyeth, Oreg..... 145
Gurley printing water-stage recorder, plate showing 9

Hellroaring Creek near Big Muddy Creek, Wash..... 145
Henshaw, F. F., and assistants, work of..... 12
Hood River at Dee, Oreg..... 72-73
at Powerdale, near Hood River, Oreg.... 76-78
at Tucker Bridge, near Hood River, Oreg. 74-75
East Fork of, near Dee, Oreg 80-81
near Mount Hood, Oreg..... 78-80
Hood River, Oreg., Pacific Power & Light Co.'s tailrace near..... 83-84
Husum, Wash., White Salmon River at..... 86-87

Jack Creek near Metolius River, Oreg..... 144
Jasper, Oreg., Middle Fork of Willamette River at..... 98
John Day River at McDonald, Oreg..... 22-23
near Prairie City, Oreg..... 21
North Fork of, near Dale, Oreg..... 144
John Day River basin, gaging-station records in 21-28, 144

Kalama River near Kalama, Wash..... 109-110
Klickitat River at Caldwell Prairie, Wash... 145
Diamond Fork at mouth on..... 145
near Glenwood, Wash..... 68-69
Klickitat River basin, gaging-station records in..... 68-71, 145

Lake Creek at outlet of Diamond Lake, Oreg. (Umpqua River basin)..... 146
Lake Creek at outlet of Packwood Lake, near Lewis, Wash. (Cowlitz River basin)..... 117-118
Lake Creek, near Sisters, Oreg. (Deschutes River basin)..... 60-61
Lake Creek, Oreg., North Fork of Little Butte Creek near..... 129-130, 145
Lapine, Oreg., Deschutes River near..... 29-32
East Fork near..... 38-39
Lewis, Wash., Clear Fork near..... 116-117
Cowlitz River at..... 112-114
Lake Creek near..... 117-118
Ohanapecosh River near..... 111-112
Lewis River near Amboy, Wash..... 108-109
Lilyglen, Oreg., Dead Indian Creek near... 127-129
Little Butte Creek above Eagle Point, Oreg. 126-127
North Fork of, near Lake Creek, Oreg.... 129-130, 145
South Fork of, near Deadwood, Oreg.... 125
Little Muddy Creek near West Fork, Wash.. 145
Little Sandy River near Marmot, Oreg..... 96-97
Lost Creek near Brightwood, Oreg..... 91-93

McDonald, Oreg., John Day River at..... 22-23
McDonald Creek near mouth on Little Applegate River, Oreg..... 145
McKay Creek near Ochoco Creek, Oreg..... 144
McKenzie River at McKenzie Bridge, Oreg. 102-103

Page.
Marks Creek at Sears ranch, Oreg..... 144
Marmot, Oreg., Sandy River below dam near 89-91
Sandy River canal near..... 93-94
Little Sandy River near..... 96-97
Mecca, Oreg., Deschutes River at..... 34-35
Medford, Oreg., Bear Creek at..... 131-133
Metolius River at Allingham ranger station, near Sisters, Oreg..... 59-60
Mill Creek near Ash, Oreg. (Umpqua River basin)..... 142-143
Mill Creek near Ochoco Creek, Oreg. (Deschutes River basin)..... 144
Mill Creek near Prospect, Oreg. (Rogue River basin)..... 145
Mill Creek near Walla Walla, Wash..... 15-17, 144
Milton, Oreg., South Fork of Walla Walla River near..... 14-15
Moody, Oreg., Deschutes River at..... 36-38
Morson intake, near Lapine, Oreg., East Fork at..... 38-39
Mossy Rock, Wash., Cowlitz River at..... 114-115
Mount Hood, Oreg., East Fork Irrigation District canal near..... 81-82
East Fork of Hood River near..... 78-80

Neil Creek near Bear Creek, Oreg..... 145
Niagara, Oreg., North Santiam River at... 103-104
North canal near Bend, Oreg..... 44-45
North Santiam River at Niagara, Oreg.... 103-104
North Umpqua River at Toketee Falls, Oreg..... 137-140
near Glide, Oreg..... 140-141

Oakridge, Oreg., North Fork of Middle Fork of Willamette River near..... 145
Salmon Creek near..... 100-102
Ochoco Creek at Elliott ranch, near Prineville, Oreg..... 55-57
Ohanapecosh River near Lewis, Wash..... 111-112

Pacific Power & Light Co.'s tailrace near Hood River, Oreg..... 83-84
Packwood Lake near Lewis, Wash., Lake Creek at outlet of..... 117-118
Paley ditch at intake of Rogue River Valley canal, Oreg..... 145
Parker, G. L., and assistants, work of..... 12
Pendleton, Oreg., Umatilla River at..... 144
Phoenix ditch at Talent, Oreg..... 133-134
Pilot Butte canal near Bend, Oreg..... 42-44
Powerdale, Oreg., Hood River at..... 76-78
Prairie City, Oreg., John Day River near.... 21
Strawberry Creek near..... 23-24, 144
Prairie Power Co.'s flume at Prairie City, Oreg..... 144
Price current meters, plate showing..... 8
Prineville, Oreg., Elliott ditch near..... 58-59
Ochoco Creek near..... 55-57
Tableland ditch near..... 57-58
Pringle Falls, Oreg., Deschutes River at..... 144
Prospect, Oreg., California-Oregon Power Co.'s flume near..... 124-125
Mill Creek near..... 145
Red Blanket Creek near..... 145
Rogue River below..... 120-122

Red Blanket Creek near Prospect, Oreg..... 145
Rogue River below Prospect, Oreg..... 120-122
near Tolo, Oreg..... 122-123

Digitized by Google

Page.
Rogue River basin, gaging-station records in 120-134, 145
Rogue River Valley canal near Brownsboro, Oreg 130-131
Paley ditch at intake of 145
Run-off (depth in inches), definition of 8

Salmon Creek near Oakridge, Oreg 100-102
Sandy River below dam near Marmot, Oreg .. 89-91
Sandy River canal near Marmot, Oreg 93-94
Sandy River basin, gaging-station records in .. 89-97
Scope of work 7-8
Second-foot, definition of 8
Second-feet per square mile, definition of 8
Sisters, Oreg., First Creek near 62-63
Lake Creek near 60-61
Metolius River near 59-60
Squaw Creek near 52-53
Squaw Creek canal near 53-54
Siuslaw River at Austa, Oreg 146
Squaw Creek near Sisters, Oreg 52-53
Squaw Creek canal near Sisters, Oreg 53-54
Stage-discharge relation, definition of 8
Sterling ditch near Glade Creek, Oreg 145
Stevens continuous water-stage recorder, plate showing 9
Strawberry Creek near Prairie City, Oreg. 23-24, 144
Swalley canal near Bend, Oreg 46-47

Tableland ditch near Prineville, Oreg 57-58
Talent, Oreg., Phoenix ditch at 133-134
Terms, definitions of 8
Thielsen Creek near Lake Creek, Oreg 146
Tokette Falls, Oreg., North Umpqua River at 137-140
Tolo, Oreg., Rogue River near 122-123
Trapper Creek near Little Muddy Creek, Wash 145
Trout Creek near Antelope, Oreg 63-64
Trout Lake, Wash., White Salmon River near 84-85
Tucker Bridge, near Hood River, Oreg., Hood River at 74-75

Page.
Tumalo Creek near Bend, Oreg 47-50
Tumalo feed canal near Bend, Oreg 50-51
Tygh Valley, Oreg., White River near 66-67

Ukiah, Oreg., Cable Creek near 28
Camas Creek near 27
Umatilla River at Pendleton, Oreg 144
below Furnish reservoir, Oreg 144
near Umatilla, Oreg 19-20
near Yoakum, Oreg 17-19
Umpqua River near Elkton, Oreg 136-137
Umpqua River basin, gaging-station records in 136-143, 146
Underwood, Wash., White Salmon River near 87-89

Walker Creek, near mouth, on Emigrant Creek, Oreg 145
Walla Walla, Wash., Mill Creek near ... 15-17, 144
Walla Walla River, South Fork of, near Milton, Oreg 14-15
Walla Walla River basin, gaging-station records in 14-17, 144
Warm Springs River near Warm Spring, Oreg 64-66
Water-stage recorders, plate showing 9
Watson Creek near Clearwater River, Oreg .. 146
White River near Tygh Valley, Oreg 66-67
White Salmon River at Husum, Wash 86-87
near Trout Lake, Wash 84-85
near Underwood, Wash 87-89
Willamette River at Albany, Oreg 99-100
Middle Fork of, at Jasper, Oreg 98
North Fork of Middle Fork of, near Oakridge, Oreg 145
Willamette River basin, gaging-station records in 98-107, 145
Work, authorization of 7
scope of 7-8
Wyeth, Oreg., Gorton Creek near 145

Yoakum, Oreg., Umatilla River near 17-19
Youngs River near Astoria, Oreg 119, 145

Zero flow, definition of 8

Digitized by Google

Digitized by Google

STREAM-GAGING STATIONS

AND

PUBLICATIONS RELATING TO WATER RESOURCES

PART XII.—NORTH PACIFIC SLOPE BASINS

Digitized by Google

Digitized by Google

STREAM-GAGING STATIONS AND PUBLICATIONS RELATING TO WATER RESOURCES.

INTRODUCTION.

Investigation of water resources by the United States Geological Survey has consisted in large part of measurements of the volume of flow of streams and studies of the conditions affecting that flow, but it has comprised also investigation of such closely allied subjects as irrigation, water storage, water powers, underground waters, and quality of waters. Most of the results of these investigations have been published in the series of water-supply papers, but some have appeared in the bulletins, monographs, professional papers, and annual reports.

The result of stream-flow measurements are now published annually in 12 parts, each part covering an area whose boundaries coincide with natural drainage as indicated below:

Part I. North Atlantic slope basins.
II. South Atlantic slope and eastern Gulf of Mexico basins.
III. Ohio River basin.
IV. St. Lawrence River basin.
V. Upper Mississippi River and Hudson Bay basins.
VI. Missouri River basin.
VII. Lower Mississippi River basin.
VIII. Western Gulf of Mexico basins.
IX. Colorado River basin.
X. Great Basin.
XI. Pacific slope basins in California.
XII. North Pacific slope basins, in three volumes:
A, Pacific slope basins in Washington and upper Columbia River basin.
B, Snake River basin.
C, Lower Columbia River basin and Pacific slope basins in Oregon.

HOW GOVERNMENT REPORTS MAY BE OBTAINED OR CONSULTED.

Water-supply papers and other publications of the United States Geological Survey containing data in regard to the water resources of the United States may be obtained or consulted as indicated below.

1. Copies may be obtained free of charge by applying to the Director of the Geological Survey, Washington, D. C. The edition printed for free distribution is, however, small and is soon exhausted.

2. Copies may be purchased at nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C., who will on application furnish lists giving prices.

Digitized by Google

3. Sets of the reports may be consulted in the libraries of the principal cities in the United States.

4. Complete sets are available for consultation in the local offices of the water-resources branch of the Geological Survey, as follows:

Boston, Mass., 2500 Customhouse.
Albany, N. Y., 704 Journal Building.
Atlanta, Ga., Post Office Building.
Nashville, Tenn., 306 Customhouse.
Madison, Wis., care of Railroad Commission of Wisconsin.
Topeka, Kans., 23 Federal Building.
Helena, Mont., Montana National Bank Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, 313 Federal Building.
Boise, Idaho, 615 Idaho Building.
Portland, Oreg., 606 Post Office Building.
Tacoma, Wash., 406 Federal Building.
San Francisco, Calif., 328 Customhouse.
Los Angeles, Calif., 619 Federal Building.
Austin, Tex., Capitol Building.
Honolulu, Hawaii, 25 Capitol Building.

A list of the Geological Survey's publications may be obtained by applying to the Director of the United States Geological Survey, Washington, D. C.

STREAM-FLOW REPORTS.

Stream-flow records have been obtained at more than 4,200 points in the United States, and the data obtained have been published in the reports tabulated below:

Stream-flow data in reports of the United States Geological Survey.

[A=Annual Report; B=Bulletin; W=Water Supply Paper.]

Report.	Character of data.	Year.
10th A, pt. 2	Descriptive information only	
11th A, pt. 2	Monthly discharge and descriptive information	1884 to September, 1890.
12th A, pt. 2	do	1884 to June 30, 1891.
13th A, pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th A, pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th A, pt. 2	Descriptive information only	
B 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W 11	Gage heights (also gage heights for earlier years)	1896.
18th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years).	1895 and 1896.
W 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th A, pt. 2	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1898.
W 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.

Digitized by Google

Stream-flow data in reports of the United States Geological Survey—Continued.

[A=Annual Report; B=Bulletin; W=Water-Supply Paper.]

Report.	Character of data.	Year.
21st A, pt. 4	Monthly discharge	1899.
W 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d A, pt. 4	Monthly discharge	1900.
W 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W 75	Monthly discharge	1901.
W 82 to 85	Complete data	1902.
W 97 to 100	do	1903.
W 124 to 135	do	1904.
W 165 to 178	do	1905.
W 201 to 214	do	1906.
W 241 to 252	do	1907–8.
W 261 to 272	do	1909.
W 281 to 292	do	1910.
W 301 to 312	do	1911.
W 321 to 332	do	1912.
W 351 to 362	do	1913.
W 381 to 394	do	1914.
W 401 to 414	do	1915.
W 431 to 444	do	1916.
W 451 to 464	do	1917.

The records at most of the stations discussed in these reports extend over a series of years, and miscellaneous measurements at many points other than regular gaging stations have been made each year. An index of the reports containing records obtained prior to 1904 has been published in Water-Supply Paper 119.

The table following gives, by years and drainage basins, the numbers of the papers on surface-water supply published from 1899 to 1917. The data for any particular station will, as a rule, be found in the reports covering the years during which the station was maintained. For example, data for Machias River at Whitneyville, Me., 1903 to 1917, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, 401, 431, and 451, which contain records for the New England streams from 1903 to 1917. Results of miscellaneous measurements are published by drainage basins.

In these papers and in the following lists the stations are arranged in downstream order. The main stem of any river is determined by measuring or estimating its drainage area—that is, the headwater stream having the largest drainage area is considered the continuation of the main stream, and local changes in name and lake surface are disregarded. All stations from the source to the mouth of the main stem of the river are presented first, and the tributaries in regular order from source to mouth follow, the streams in each tributary basin being listed before those of the next basin below.

In exception to this rule the records for Mississippi River are given in four parts, as indicated on page III, and the records for large lakes are presented in order of the streams around the rim of the lake.

Digitized by Google

Numbers of water-supply papers containing results of stream measurements, 1899–1917.

Year.	I North Atlantic slope basins (St. John River to York River).	II South Atlantic slope and eastern Gulf of Mexico basins (James River to the Mississippi).	III Ohio River basin.	IV St. Lawrence River basin.	V Hudson Bay and upper Mississippi River basins.	VI Missouri River basin.	VII Lower Mississippi River basin.	VIII Western Gulf of Mexico basins.	IX Colorado River basin.	X Great Basin.	XI Pacific slope basins in California.	XII North Pacific slope basins. Pacific slope basins in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific slope basins in Oregon.
1899 [a]	35	[b] 35, 36	36	36	36	[c] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900 [g]	47, [h] 48	48	48, [i] 49	49	49	49, [j] 50	50	50	50	51	51	51	51	51
1901	65, 75	65, 75	65, 75	65, 75	[k] 65, 66, 75	66, 75	[k] 65, 66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75
1902	82	[b] 82, 83	83	[l] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[k] 98, 99, [m] 100	99	[k] 98, 99	99	100	100	100	100	100	100
1904	[n] 124, [o] 125, [p] 126	[p] 126, 127	128	129	[k] 128, 130	130, [q] 131	[k] 128, 131	132	133	133, [r] 134	134	135	135	135
1905	[n] 165, [o] 166, [p] 167	[p] 167, 168	169	170	171	172	[k] 169, 173	174	175, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906	[n] 201, [o] 202, [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911	301	302	303	304	305	306	307	308	309	310	311	312	312	312
1912	321	322	323	324	325	326	327	328	329	330	331	332–A	332–B	332–C
1913	351	352	353	354	355	356	357	358	359	360	361	362–A	362–B	362–C
1914	381	382	383	384	385	386	387	388	389	390	391	392	393	394
1915	401	402	403	404	405	406	407	408	409	410	411	412	413	414
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444
1917	451	452	453	454	455	456	457	458	459	460	461	462	463	464

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water Supply Paper 39. Tables for monthly discharge for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Gallatin River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific slope basins.
[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Tables for monthly discharge for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Scioto River.
[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.
[k] Tributaries of Mississippi from east.
[l] Lake Ontario and tributaries to St. Lawrence River proper.
[m] Hudson Bay only.
[n] New England Rivers only.
[o] Hudson River to Delaware River, inclusive.
[p] Susquehanna River to Yadkin River, inclusive.
[q] Platte and Kansas Rivers.
[r] Great Basin in California except Truckee and Carson river basins.
[s] Below junction with Gila.
[t] Rogue, Umpqua, and Siletz rivers only.

Digitized by Google

NORTH PACIFIC SLOPE DRAINAGE BASINS.

PRINCIPAL STREAMS.

The largest rivers discharging into the Pacific Ocean in Oregon nd Washington are Rogue, Umpqua, and Columbia rivers and treams that reach the ocean through Puget Sound. The principal ributaries of the Columbia are Kootenai, Clark Fork, Spokane, Venatchee, Yakima, Snake, Walla Walla, Umatilla, John Day, Deshutes, Klickitat, Willamette, and Lewis rivers. Nisqually, Puyallup, Vhite, Snohomish, and Skagit rivers flow into Puget Sound. The treams of this division drain wholly or in part the States of Idaho, Iontana, Nevada, Oregon, Utah, Washington, and Wyoming.

In addition to the list of gaging stations and the annotated list of ublications relating specifically to the section, these pages contain a imilar list of reports that are of general interest in many sections and over a wide range of hydrologic subjects, and also brief references to eports published by State and other organizations (p. xxxii).

GAGING STATIONS.

NOTE.—Dash after date indicates that station was being maintained September 30, 1917. Period after date indicates discontinuance.

BETWEEN COLUMBIA RIVER AND PUGET SOUND.

Chehalis River at Centralia, Wash., 1910–11.
Quinault River at Quinault Lake, Wash., 1911–
Soleduck River near Quillayute, Wash., 1897–1901.
Kalawa River near Forks, Wash., 1897–1901.
Elwha River at McDonald, Wash., 1897–1901.
Elwha River near Port Angeles, Wash., 1911–12.
Dungeness River at Sequim, Wash., 1897–98.
Dungeness River at Dungeness, Wash., 1898–1901.

PUGET SOUND DRAINAGE BASINS.

Dosewallips River at Brinnon, Wash., 1910–11.
Duckabush River near Duckabush, Wash., 1910–11.
Skokomish River, North Fork (head of Skokomish River), near Hoodsport, Wash., 1910–11; 1913–
Nisqually River near Ashford, Wash., 1910–1914.
Nisqually River near La Grande, Wash., 1906–1911.
Puyallup River near Electron, Wash., 1909–
Puyallup River at Alderton, Wash., 1914–
Puyallup River at Puyallup, Wash., 1914–
Carbon River at Fairfax, Wash., 1910–1912.
White River below Forks, near Enumclaw, Wash., 1911–12.
White River at Buckley, Wash., 1899–1903; 1910–11; 1913–
Greenwater River at mouth, near Enumclaw, Wash., 1911–12.
White River flume at Buckley, Wash., 1913–
Green River at Kanaskat, Wash., 1911.
Duwamish River:
Cedar River at Vaughn Bridge, near Cedar Lake, Wash., 1898–99.
Cedar River at Cedar Lake, near North Bend, Wash., 1902–3.

Digitized by Google

Duwamish River—Continued
- Cedar River at Cedar Falls, Wash., 1914–
- Cedar River near Landsberg, Wash., 1914–
- Cedar River near Ravensdale, Wash., 1901–1912.
- Cedar River at Clifford Bridge, near Ravensdale, Wash., 1895–1898.
- Cedar River at Renton, Wash., 1901–1907. (Published in Water-Supply Paper 313.)

Skykomish River, South Fork (head of Snohomish River), near Berlin, Wash., 1910–11.
Skykomish River, South Fork, near Index, Wash., 1902–1905; 1911–12, 1913–
Skykomish River at Sultan, Wash., 1910–11.
- Foss River near Skykomish, Wash, 1911.
  - East Fork of Foss River near Skykomish, Wash., 1911.
- Miller Creek near Miller River (Berlin), Wash., 1911–
  - West Fork of Miller Creek near Miller River (Berlin), Wash., 1911.
- North Fork of Skykomish River at Index, Wash., 1910–
- Sultan River near Sultan, Wash., 1911–
- Snoqualmie River, Middle Fork (head of Snoqualmie River), near North Bend, Wash., 1907– (Records for this station and other stations in Snoqualmie River basin published in Water-Supply Paper 412.)
- Snoqualmie River near Snoqualmie, Wash., 1898–99; 1900; 1902–1904. (Revised records published in Water-Supply Paper 412.)
  - North Fork of Snoqualmie River at cable bridge, near North Bend, Wash., 1913–1915.
  - North Fork of Snoqualmie River near North Bend, Wash., 1907–
  - South Fork of Snoqualmie River near Garcia, Wash., 1910–1915.
  - South Fork of Snoqualmie River at North Bend, Wash., 1907–
  - Tokul Creek near Snoqualmie, Wash., 1907–1914.
- Pilchuck Creek near Granite Falls, Wash., 1911.

Stilaguamish River, South Fork (head of Stilaguamish River), near Silverton, Wash., 1910–1917.
Stilaguamish River, South Fork, near Robe, Wash., 1902–3.
Stilaguamish River, South Fork at Granite Falls, Wash., 1911; 1913–1915.
- Canyon Creek near Granite Falls, Wash., 1911–1913.

Skagit River at Reflector Bar, near Marblemount, Wash., 1913–
Skagit River near Marblemount, Wash., 1908–1914.
Skagit River near Sedro Woolley, Wash., 1908–
- Stetattle Creek near Marblemount, Wash., 1913–1915.
- Cascade River near Marblemount, Wash., 1909–1913.
- Sauk River above Whitechuck River, near Darrington, Wash., 1910.
- Sauk River above Clear Creek, near Darrington, Wash., 1910–1913.
- Sauk River at Darrington, Wash., 1914–
- Sauk River near Suiattle Crossing, near Sauk, Wash., 1910–1912.
  - Whitechuck River near Darrington, Wash., 1910.
  - Clear Creek near Darrington, Wash., 1910–11.
- Baker Lake (on Baker River) near Concrete, Wash., 1910–1915.
- Baker River below Anderson Creek, near Concrete, Wash., 1910–
- Baker River at Concrete, Wash., 1910–1915.

Whatcom Lake near Bellingham, Wash., 1913–14.
Whatcom Creek near Bellingham, Wash., 1910–1914.
Nooksack River,[1] North Fork (head of Nooksack River), near Glacier, Wash., 1910–11.
Nooksack River near Deming, Wash., 1910-11.
- Middle Fork of Nooksack River at ranger station near Deming, Wash. 1910.
- Middle Fork of Nooksack River near Deming, Wash., 1910–11.

[1] Revised decision of United States Geographic Board rendered Oct. 3, 1917.

Digitized by Google

COLUMBIA RIVER BASIN.

Columbia River at Trail, British Columbia, 1913–
Columbia River at Wenatchee, Wash., 1910; 1913–1916.
Columbia River at Vernita, Wash., 1917–
Columbia River near Julia, Wash., 1905.
Columbia River at Hanford, Wash., 1910.
Columbia River at Pasco, Wash., 1904–1910.
Columbia River at Cascade Locks and The Dalles, Oreg., 1878–
Kootenai River at Libby Mont., 1910–
Kootenai River at Crossport, Idaho, 1904.
Kootenai River near Bonners Ferry, Idaho, 1904.
Kootenai River near Porthill, Idaho, 1904.
Callahan Creek at Troy, Mont., 1911–1916.
Yaak River near Troy, Mont., 1910–1916.
Moyie River at Snyder, Idaho, 1911–1916.
Clark Fork at Missoula, Mont., 1898-1907.
Clark Fork at St. Regis, Mont., 1910–
Clark Fork near Plains, Mont., 1910–
Pend Oreille Lake at Sandpoint, Idaho, 1914–
Clark Fork at Priest River, Idaho, 1903–1905.
Clark Fork at Newport, Wash., 1904–1910.
Clark Fork at Metaline Falls, Wash., 1908–1910; 1912–
Racetrack Creek near Anaconda, Mont., 1911–12; 1914–
Little Blackfoot River and ditch near Elliston, Mont., 1910-1915.
Rock Creek near Quigley, Mont., 1910–1912.
Big Blackfoot River at Bonner, Mont., 1898–1905.
Rattlesnake Creek at Missoula, Mont., 1899–1900.
Bitterroot River, West Fork (head of Bitterroot River), near Darby, Mont., 1910–
Bitterroot River near Grantsdale, Mont., 1902–1907.
Bitterroot River near Missoula, Mont., 1898–1901; 1903–4.
East Fork of Bitterroot River near Darby, Mont., 1910–1916.
Lolo Creek near Lolo, Mont., 1910–1916.
St. Regis River near St. Regis, Mont., 1910–
Flathead River near Columbia Falls, Mont., 1910–
Flathead River at Demersville, near Kalispell, Mont., 1909–1912.
Flathead River at Damon's ranch near Kalispell, Mont., 1909–1912.
Flathead River at Keller's ranch, near Holt., Mont., 1909–1912.
Flathead Lake (on Flathead River) near Holt, Mont., 1900.
Flathead Lake at Polson, Mont., 1908–.
Flathead River near Polson, Mont., 1907–
Middle Fork of Flathead River at Belton, Mont., 1910–
Lake McDonald outlet at Lake McDonald, Mont., 1912–1914.
South Fork of Flathead River near Columbia Falls, Mont., 1910–1916.
Stillwater River near Kalispell, Mont., 1906–7.
Whitefish River near Kalispell, Mont., 1906.
Ashley Creek, Kila, Mont., 1916.
Swan River near Big Fork, Mont., 1910–11
Big Creek, near Polson, Mont., 1917–
Little Bitterroot River near Marion, Mont., 1910–1916.
Little Bitterroot River near Hubbart, Mont., 1909–1916.
Little Bitterroot River near Niarada (Dayton), Mont., 1908–9; 1916.
Crow Creek near Ronan, Mont., 1906–

Digitized by Google

Columbia River tributaries—Continued.
Clark Fork tributaries—Continued.
Flathead River tributaries—Continued.
Crow Creek at Lozeau's ranch, near Ronan, Mont., 1911–1916.
Mud Creek near Ronan, Mont., 1908–1910.
Mission Creek near St. Ignatius, Mont., 1906.
Dry Creek near St. Ignatius, Mont., 1908–1916.
Post Creek at Fitpatrick's ranch, near Ronan, Mont., 1906–1911.
Post Creek at Deschamp's ranch near Ronan, Mont., 1911.
Post Creek near St. Ignatius, Mont., 1911–
Jocko River, South Fork (head of Jocko River), near Jocko, Mont., 1912–1916.
Jocko River near Jocko, Mont., 1908–1916.
Jocko River at Ravalli, Mont., 1906–1911.
Middle Fork of Jocko River near Jocko, Mont., 1912–1916.
North Fork of Jocko River near Jocko, Mont., 1912–1916.
Falls Creek near Jocko, Mont., 1912–1916.
Big Knife Creek near Jocko, Mont., 1908–1916.
Agency Creek near Jocko, Mont., 1908–1916.
Blodgett Creek near Jocko, Mont., 1909–10.
Finley Creek near Jocko, Mont., 1908–1916.
East Finley Creek near Jocko, Mont., 1908–1916.
Indian ditch near Jocko, Mont., 1908–1911; 1912–1916.
Valley Creek near Ravalli, Mont., 1908–1911.
Revais Creek near Dixon, Mont., 1911–1916.
Thompson River near Thompson Falls, Mont., 1911–1916.
Prospect Creek near Thompson Falls, Mont., 1911–1916.
Priest River at outlet of Priest Lake, at Coolin, Idaho, 1911–1917.
Priest River at Falk's ranch, near Priest River, Idaho, 1911–12.
Priest River near Priest River, Idaho, 1903–1905; 1910–11.
Sullivan Lake near Metaline Falls, Wash., 1912–
Sullivan Creek near Metaline Falls, Wash., 1912–
Kettle River at Curlew, Wash., 1911–12.
Kettle River at Boyds, Wash., 1913–1915.
Curlew Creek near Curlew, Wash., 1917–
Hall Creek at Inchelium, Wash., 1912–
Stranger Creek at Meteor, Wash., 1916–
Stranger Creek at Inchelium, Wash., 1914–1917.
North Fork of Cœur d'Alene River (head of Cœur d'Alene River and through Cœur d'Alene Lake of Spokane River) at Pritchard, Idaho, 1911–1914.
North Fork of Cœur d'Alene River at Enaville, Idaho, 1911–1913.
Cœur d'Alene River near Cataldo, Idaho, 1911–12.
Cœur d'Alene Lake at Cœur d'Alene, Idaho, 1903–
Spokane River at Post Falls, Idaho, 1913–1917.
Spokane River at Trent, Wash., 1911–1913.
Spokane River at Washington Water Power Co.'s dam, at Spokane, Wash., 1891–1896.
Spokane River at Spokane, Wash., 1896–
Spokane River, below Little Falls, near Long Lake, Wash., 1912–
Little North Fork of Cœur d'Alene River near Enaville, Idaho, 1911–12.
St. Joe River at Avery, Idaho, 1911–1917.
St. Joe River near Calder, Idaho, 1911–12.
St. Maries River at Lotus, Idaho, 1911–12.
Spokane Valley Land & Water Co.'s canal near Post Falls, Idaho, 1911–1917.

Digitized by Google

Columbia River tributaries—Continued.
Spokane River tributaries—Continued.
Latah (Hangman) Creek at and near Tekoa, Wash., 1904–5.
North Fork of Latah Creek near Tekoa, Wash., 1904–5.
Little Spokane River near Spokane, Wash., 1903–1905; 1911–1913.
Sanpoil River at Keller, Wash., 1911–1917.
Nespelem River at Nespelem, Wash., 1911–
Okanogan River at Okanogan, Wash., 1911–
Similkameen River near Oroville, Wash., 1911–
Sinlahekin Creek near Loomis, Wash., 1903–1905.
Johnson Creek near Riverside, Wash., 1903–1907.
Salmon Creek near Conconully, Wash., 1910–
Salmon Creek near Okanogan, Wash., 1903–1912.
Methow River at Winthrop, Wash., 1912.
Methow River at Pateros, Wash., 1903–
Chewack Creek at Winthrop, Wash., 1912–13.
Twisp River at Twisp, Wash., 1911–1913.
Stehekin River (head of Chelan River) at Stehekin, Wash., 1910–1915.
Chelan Lake at Lakeside, Wash., 1897–1899.
Chelan Lake at Chelan, Wash., 1905; 1910–
Chelan River at Chelan, Wash., 1903–
Railroad Creek at Lucerne, Wash., 1910–1913.
Entiat River at Entiat, Wash., 1910–
Wenatchee River near Leavenworth, Wash., 1910–
Wenatchee River at Dryden (Cashmere), Wash., 1904–1917.
Wenatchee River near Wenatchee, Wash., 1897.
White River near Chiwaukum, Wash., 1911–12; 1914.
Nason Creek near Nason, Wash., 1911.
Chiwawa River near Leavenworth, Wash., 1911–12; 1913–14.
Chiwaukum Creek near Chiwaukum, Wash., 1911.
Icicle Creek near Leavenworth, Wash., 1911–1914.
Peshastin Creek at Blewett, Wash., 1911–12.
Peshastin Creek near Leavenworth, Wash., 1911–12.
Wenatchee Valley canal at Dryden, Wash. (irrigation seasons only), 1912–1917
Crab Creek at Wilson Creek, Wash., 1904.
Crab Creek at Adrian, Wash., 1910; 1911; 1912.
Crab Creek near Ephrata, Wash., 1909.
Moses Lake at Neppel (Moses Lake), Wash., 1909–1914.
Crab Creek near Warden, Wash., 1909–1912.
Rocky Ford Creek near Ephrata, Wash., 1909–1911.
Keechelus Lake (on Yakima River) near Martin, Wash., 1906–
Yakima River near Martin, Wash., 1903–
Yakima River at Easton, Wash., 1904; 1910–1915.
Yakima River at Cle Elum, Wash., 1906–
Yakima River at Umtanum, Wash., 1906–
Yakima River at Selah Gap, near North Yakima, Wash., 1897; 1904–5; 1911; 1912.
Yakima River at Union Gap, near Yakima City, Wash., 1894–1909; 1911–1914.
Yakima River near Parker (Wapato), Wash., 1908–
Yakima River at Mabton, Wash., 1904–1906; 1911–12.
Yakima River near Prosser, Wash., 1904–1906; 1913–
Yakima River at Kiona, Wash., 1895–1915.
Yakima River near Richland, Wash., 1906–1911.
Cabin Creek near Easton, Wash., 1909–1911.
Kachess Lake (on Kachess River) near Easton, Wash., 1905–

Digitized by Google

Columbia River tributaries—Continued.
Yakima River tributaries—Continued.
Kachess River near Easton, Wash., 1903–
Big Creek near Cle Elum, Wash., 1909.
Cle Elum River, North Fork (head of Cle Elum River), at Galena, Wash., 1907; 1911.
Cle Elum Lake near Roslyn, Wash., 1906–
Cle Elum River near Roslyn, Wash., 1903–
Teanaway River below Forks, near Cle Elum, Wash., 1911–12.
Teanaway River near Cle Elum, Wash., 1909–1911; 1912–1914.
Swauk Creek near Cle Elum, Wash., 1909–1912.
Cascade canal near Ellensburg (Thorp), Wash., 1905–6; 1909–1911.
West Kittitas canal near Thorp, Wash., 1904–1906; 1909–1911.
Ellensburg Water Co.'s canal near Ellensburg, Wash., 1904–5; 1909–1911.
Taneum Creek near Thorp, Wash., 1909–1912.
Manastash Creek near Ellensburg, Wash., 1909–1914.
Wilson Creek near Thrall, Wash., 1911.
Selah Moxee canal near Selah, Wash., 1904–5; 1909–1911.
Wenas Creek near Selah, Wash., 1909–1912.
Naches River at Anderson's ranch, near Nile, Wash., 1909–1914.
Naches River at Oak Flat, near Nile, Wash., 1904–1917.
Naches River below Tieton River, near Naches, Wash., 1905; 1909–1912; 1915–
Naches River near North Yakima, Wash., 1893–1897; 1898–1912.
Bumping Lake (on Bumping River) near Nile, Wash., 1909; 1910–
Bumping River at Bumping Lake, near Nile, Wash., 1906; 1909–
American River near Nile, Wash., 1909; 1910; 1911; 1913; 1914; 1915.
Selah Valley canal near Naches, Wash., 1904–1906; 1909–1912.
Tieton River, North Fork, below Clear Creek, near Naches, Wash., 1914–15.
Tieton River at McAllister Meadows, near Naches, Wash., 1908–1914.
Tieton River at headworks of Tieton canal, near Naches, Wash., 1906–
Tieton River at Cobb's ranch, near Naches, Wash., 1902–1913.
Tieton canal near Naches, Wash., 1910–
Wapatox canal near Naches, Wash., 1904–5; 1909–1911.
Naches Canal Co.'s (Gleed) canal near Naches, Wash., 1904–1906; 1909–1911.
Yakima Valley (Congdon) canal near Naches, Wash., 1904–1906; 1909–1911.
Naches-Cowiche canal near Naches, Wash., 1904–5; 1909–1911.
North Yakima power canal near North Yakima, Wash., 1904–1906; 1909–10.
Schanno canal near North Yakima, Wash., 1904–5; 1909–1911.
North Yakima power waste at North Yakima, Wash., 1909–1912.
North Yakima mill waste at North Yakima, Wash., 1909–1912.
Naches Avenue Union canal at North Yakima, Wash., 1904–1906; 1909–1911.
Old Union canal near North Yakima, Wash., 1904–1906; 1909–1911.
Moxee Co.'s canal near North Yakima, Wash., 1904–1906; 1909–1911.
Fowler canal near North Yakima, Wash., 1904–1906; 1909–1911.
Ahtanum Creek, North Fork (head of Ahtanum Creek), near Tampico, Wash., 1907–
Ahtanum Creek at The Narrows, near Tampico, Wash., 1908–1913.
Ahtanum Creek near Yakima, Wash., 1904; 1907–1912.
South Fork of Ahtanum Creek at Conrad ranch, near Tampico, Wash., 1915–
South Fork of Ahtanum Creek near Tampico, Wash., 1907–1914.

Digitized by Google

Columbia River tributaries—Continued.
Yakima River tributaries—Continued.
New Reservation canal at Parker (Yakima City), Wash., 1904–
Old Reservation canal at Parker (Wapato), Wash., 1904–
Sunnyside canal near Parker (Wapato), Wash., 1904–
Toppenish Creek near Fort Simcoe, Wash., 1909–
Toppenish Creek near White Swan (Wapato)' Wash., 1909–1912.
Toppenish Creek at railway bridge, near Toppenish, Wash., 1894–1896.
Toppenish Creek near Toppenish, Wash., 1908–9.
Toppenish Creek at Alfalfa, Wash., 1909–1912.
Simcoe Creek near Fort Simcoe, Wash., 1909–
Reservation drain at Alfalfa, Wash., 1912–
Satus Creek near Toppenish, Wash., 1908–1913.
Satus Creek below Dry Creek, near Toppenish, Wash., 1913–
Satus Creek near Alfalfa, Wash., 1905.
Satus Creek near Satus, Wash., 1894–1896.
Kiona canal near Kiona, Wash., 1904–1906; 1908–1911.
Kennewick canal near Richland (Kennewick), Wash., 1904–5; 1910–11.
Lower Yakima canal near Kiona, Wash., 1905; 1910–11.
Snake River at south boundary of Yellowstone National Park, Wyo., 1913–
Jackson Lake (Snake River) at Moran, Wyo., 1909–10 (fragmentary); 1911–
Snake River [1] near Moran, Wyo., 1903–
Snake River [1] at Grovont, Wyo., 1899.
Snake River at Alpine, Idaho, 1916–
Snake River [1] near Lyon, Idaho, 1903–1911.
Snake River [1] near Heise, Idaho, 1910–
Snake River at Idaho Falls, Idaho, 1889–90; 1892–1894.
Snake River near Shelley, Idaho, 1915–
Snake River near Firth, Idaho, 1915–
Snake River at Porterville Bridge near Blackfoot, Idaho, 1916–
Snake River near Blackfoot, Idaho, 1910–
Snake River at Neeley, Idaho, 1906–
Lake Walcott (on Snake River) near Minidoka, Idaho, 1909–
Snake River at Howells Ferry, near Minidoka, Idaho, 1910–
Snake River at Montgomery Ferry, near Minidoka, Idaho, 1895–1899; 1901–1910.
Lake Milner (on Snake River) at Milner, Idaho, 1911–
Snake River at Milner, Idaho, 1909–
Snake River near Twin Falls, Idaho, 1911–1917.
Snake River near Hagerman, Idaho, 1912–1917.
Snake River at King Hill, Idaho, 1909–
Snake River near Murphy, Idaho, 1912; 1913–
Snake River at Weiser, Idaho, 1910–
Snake River at Lewiston, Idaho, 1910.
Snake River at Riparia, Wash., 1916–
Snake River near Burbank, Wash., 1907–1917.
Pacific Creek near Moran, Wyo., 1906; 1917.
Buffalo Fork near Elk (Moran), Wyo., 1906; 1917.
Spread Creek near Elk, Wyo., 1917.
Cottonwood Creek near Teton, Wyo., 1917.
Spring Creek near Teton, Wyo., 1917.
Spring Creek near Zenith, Wyo., 1917.
Gros Ventre River at Zenith, Wyo., 1917.

[1] Decision of United States Geographic Board; formerly called South Fork of Snake River.

Digitized by Google

Columbia River tributaries—Continued.
Snake River tributaries—Continued.
Spring Creek at Zenith, Wyo., 1917.
Fish Creek near Wilson, Wyo., 1917.
Mosquito Creek near Wilson, Wyo., 1917.
Flat Creek near Cheney, Wyo., 1917.
Horse Creek near Cheney, Wyo., 1917.
Hoback River near Cheney, Wyo., 1917.
Fall Creek near Cheney, Wyo., 1917.
Dog Creek near Cheney, Wyo., 1917.
Cabin Creek near Cheney, Wyo., 1917.
Bailey Creek near Alpine, Idaho, 1917.
Wolf Creek near Alpine, Idaho, 1917.
Greys River near Alpine, Idaho, 1917.
Salt River near Alpine, Idaho, 1917.
McCoy Creek near Alpine, Idaho, 1917.
Indian Creek near Blowout, Idaho, 1917.
Big Elk Creek near Blowout, Idaho, 1917.
Little Elk Creek near Blowout, Idaho, 1917.
Bear Creek near Irwin, Idaho, 1917.
Palisade Creek near Irwin, Idaho, 1917.
Fall Creek near Swan Valley, Idaho, 1917.
Rainy Creek at Swan Valley, Idaho, 1917.
Pine Creek near Swan Valley, Idaho, 1917.
Burns Creek near Heise, Idaho, 1917.
Henrys Fork[1] at Warm River, Idaho, 1910-1915.
Henrys Fork near Ora, Idaho, 1902-1909.
Henrys Fork in canyon above Fall River, Idaho, 1890-91.
Henrys Fork near Rexburg, Idaho, 1909-
Warm River at Warm River, Idaho, 1912-1915.
Robinson Creek at Warm River, Idaho, 1912-1915.
Fall River near Marysville, Idaho, 1902-3.
Fall River at Fremont, Idaho, 1904-1909 (replace Marysville station).
Fall River at Canyon, Idaho, 1890-1901.
Teton River near St. Anthony, Idaho, 1903-1909.
Teton River at Chase's ranch, Idaho, 1890-1893.
Idaho (Government) canal near Shelley, Idaho, 1912-
Willow Creek near Prospect, Idaho, 1903-4.
Willow Creek near Ririe, Idaho, 1916-
Willow Creek near Ionia, Idaho, 1916-
Grays Lake outlet near Herman, Idaho, 1916-
Sand Creek near Firth, Idaho, 1916-
Blackfoot River above reservoir, near Henry, Idaho, 1914-
Blackfoot-Marsh reservoir near Henry, Idaho, 1912-
Blackfoot River below reservoir, near Henry [near Rossfork], Idaho, 1908-
Blackfoot River near Shelley, Idaho, 1909-
Blackfoot River near Presto, Idaho, 1903-1909.
Blackfoot River near Blackfoot, Idaho, (fragmentary), 1913; 1914; 1915-
Little Blackfoot River at Henry, Idaho, 1914-
Meadow Creek near Henry, Idaho, 1914-
Idaho (Government) canal near Firth, Idaho, 1914-
Fort Hall upper canal near Blackfoot, Idaho, 1912-
Fort Hall lower canal near Blackfoot, Idaho, 1912-

[1] Decision of United States Geographic Board; formerly called North Fork of Snake River.

Digitized by Google

Columbia River tributaries—Continued.
Snake River tributaries—Continued.
Big Lost River near Chilly, Idaho, 1904–1906; 1907–1915.
Big Lost River near Mackay, Idaho, 1903–1906; 1912–1915.
Thousand Springs Creek near Chilly, Idaho, 1912–13; 1914.
Sharp ditch near Mackay, Idaho, 1912–1914.
Streeter ditch near Mackay, Idaho, 1913–14.
Cedar Creek above forks; near Mackay, Idaho, 1911–1913.
Cedar Creek below forks, near Mackay, Idaho, 1911–1913.
Antelope Creek near Darlington, Idaho, 1913–1916.
Little Lost River near Clyde, Idaho, 1910–1913.
Birch Creek near Kaufman, Idaho, 1910–1912.
Camas Creek near Hamer, Idaho, 1912–13.
Portneuf River above reservoir, near Chesterfield, Idaho, 1912–1914.
Portneuf diversion channel near Chesterfield, Idaho, 1914.
Portneuf River below reservoir, near Chesterfield, Idaho, 1912–1915.
Portneuf River near Pebble, Idaho, 1910–1913.
Portneuf River at Topaz, 1913–1915.
Portneuf River near McCammon, Idaho, 1896.
Portneuf River at Pocatello, Idaho, 1897–1899; 1911–
Topons Creek near Chesterfield, Idaho, 1912–1914.
Pebble Creek near Pebble, Idaho, 1911–1914.
Birch Creek near Downey, Idaho, 1911–1914.
Raft River near Bridge, Idaho, 1909–1915.
Clear Creek near Naf, Idaho, 1910–11; 1912.
Cassia Creek near Conant, Idaho, 1909–1912.
North Side Minidoka canal near Minidoka, Idaho, 1909–
South Side Minidoka canal near Minidoka, Idaho, 1909–
Goose Creek above Trapper Creek, near Oakley, Idaho, 1911–1916.
Goose Creek near Oakley, Idaho, 1909–1911.
Trapper Creek near Oakley, Idaho, 1911–1916.
Birch Creek near Oakley, Idaho, 1912–13; 1914–1916.
North Side Twin Falls canal at Milner, Idaho, 1909–
South Side Twin Falls canal at Milner, Idaho, 1909–
Big Cottonwood Creek near Oakley, Idaho, 1909–1915.
Dry Creek near Artesian City, Idaho, 1912.
Rock Creek near Rock Creek, Idaho, 1909–1913.
McMullen Creek near Rock Creek, Idaho, 1910; 1912.
Salmon Falls Creek above upper Vineyard ditch, near Contact, Nev., 1914.
Salmon Falls Creek below upper Vineyard ditch, near Contact, Nev., 1914.
Salmon Falls Creek below High Lane canal, near San Jacinto Nev., 1914.
Salmon Falls Creek near San Jacinto, Nev., 1909–1916.
Salmon Falls Creek near Twin Falls, Idaho, 1909–10.
Upper Vineyard ditch near Contact, Nev., 1914.
Lower Vineyard ditch near Contact, Nev., 1914.
Jakes Creek above Hubbard ranch, near Contact, Nev., 1914.
Jakes Creek below Hubbard ranch, near Contact Nev., 1914.
Willow Creek near Contact, Nev., 1914.
Bird's Nest ditch near Contact, Nev., 1914.
Harrell ditch near Contact, Nev., 1914.
High Line ditch near San Jacinto, Nev., 1914.
San Jacinto ditch near San Jacinto, Nev., 1914.
Island ditch near San Jacinto, Nev., 1914.
West Boar's Nest ditch near San Jacinto, Nev., 1914.

Digitized by Google

Columbia River tributaries—Continued.
Snake River tributaries—Continued.
Salmon Falls Creek tributaries—Continued.
Trout Creek near San Jacinto, Nev., 1914.
East Boar's Nest ditch near San Jacinto, Nev., 1914.
Shoshone Creek near San Jacinto, Nev., 1914–15.
North Side ditch near San Jacinto, Nev., 1914.
Cedar Creek near Roseworth, Idaho, 1909–1914; 1916.
Devil Creek near Three Creek, Idaho, 1912–1914; 1916.
Big Wood River near Gimlet, Idaho, 1904–5.
Big Wood River at Hailey, Idaho, 1889; 1915–16.
Big Wood Slough at Hailey, Idaho, 1915–16.
Big Wood River near Bellevue, Idaho, 1911–1916.
Big Wood River below Magic dam, near Richfield, Idaho, 1911–1916.
Big Wood River below North Gooding canal, near Shoshone, Idaho, 1911. 1912–1916.
Big Wood River near Gooding, Idaho, 1916–
Big Wood River near Shoshone, Idaho, 1905–6; 1908–1913.
Big Wood River at Toponis, Idaho, 1896–1899.
Big Wood River near Bliss, Idaho, 1899.
Camas Creek near Blaine, Idaho, 1912–1916.
Little Wood River near Carey, Idaho, 1904–5.
Little Wood River near Richfield, Idaho, 1911–1916.
Little Wood River at Toponis [Gooding], Idaho, 1896–1899.
Dry Creek near Blanche, Idaho, 1911–1914.
King Hill Creek near King Hill, Idaho, 1913.
Little Canyon Creek at Glenns Ferry, Idaho, 1909–1913.
Alkali Creek near Glenns Ferry, Idaho, 1909–1913.
Cold Springs Creek near Hammett, Idaho, 1909–1913.
Bennett Creek near Hammett, Idaho, 1909–1913.
Rattlesnake Creek near Mountain Home, Idaho, 1917.
Canyon Creek near Mountain Home, Idaho, 1917.
Long Tom Creek below reservoir near Bennett, Idaho, 1917.
Willowdale Creek near Bennett, Idaho, 1917.
Syrup Creek near Mountain Home, Idaho, 1917.
Bruneau River near Rowland, Nev., 1913–
Bruneau River near Tindall, Idaho, 1910–1912.
Bruneau River near Hot Spring, Idaho, 1909–1915.
Bruneau River near Grandview, Idaho, 1895–1903; 1909–1916.
Sheep Creek near Tindall, Idaho, 1910–1913.
Marys Creek near Owyhee, Nev., 1913–1915.
Marys Creek at Tindall, Idaho, 1910–1913.
Louse Creek near Wickahoney, Idaho, 1911.
East Fork of Bruneau River near Three Creek, Idaho, 1912–1914; 1916.
East Fork of Bruneau River near Hot Spring, Idaho, 1910–1915.
Three Creek near Three Creek, Idaho, 1912–1914; 1916.
Cherry Creek near Three Creek, Idaho, 1912–1914; 1916.
Deadwood Creek near Three Creek, Idaho, 1912–1914; 1916.
Buckaroo ditch at Hot Spring, Idaho, 1912–1914.
Grandview canal near Grandview, Idaho, 1912–1915.
Castle Creek near Castle Creek, Idaho, 1910–11.
Sucker Creek near Homedale, Idaho, 1903–1910.
Owyhee River near Gold Creek, Nev., 1916–
Owyhee River at Mountain City, Nev., 1913.

Digitized by Google

Columbia River tributaries—Continued.
Snake River tributaries—Continued.
Owyhee River near Owyhee, Nev., 1913–
Owyhee River at Owyhee, Oreg., 1890–1896; 1903–1916.
South Fork of Owyhee River near Tuscarora, Nev., 1913.
Jack Creek near Tuscarora, Nev., 1913–
Jordan Creek near Jordan Valley, Oreg., 1911–
Cow Creek at Narrows, near Jordan Valley, Oreg., 1914.
Cow Creek at mouth, near Jordan Valley, Oreg., 1914.
Owyhee canal near Owyhee, Oreg., 1904–5; 1911–1916.
Boise River near Twin Springs, Idaho, 1911–
Boise River at Dowling's ranch, near Arrowrock, Idaho, 1911–
Boise River below Moore Creek, near Arrowrock, Idaho, 1915–16.
Boise River near Highland, Idaho (replaces the Boise station), 1905–1915.
Boise River near Boise, Idaho, 1894–1904.
Boise River at Caldwell, Idaho, 1895–96.
Cottonwood Creek near Arrowrock, Idaho, 1914–1917.
South Fork of Boise River near Lenox, Idaho, 1911–
Little Camas Creek below reservoir near Bennett, Idaho, 1917.
Little Camas canal at heading near Bennett, Idaho, 1917.
Little Camas canal above tunnel No. 9, near Bennett, Idaho, 1917.
Smith Creek near Lenox, Idaho, 1916–17.
Long Gulch Creek near Lenox, Idaho, 1916.
Rattlesnake Creek near Lenox, Idaho, 1916–17.
Willow Creek near Lenox, Idaho, 1916–17.
Little Camas Creek near Little Camas Store, Idaho, 1896.
Moore Creek near Arrowrock, Idaho, 1915–
Grimes Creek near Centerille, Idaho, 1910.
Dry Creek:
Spring Creek near Boise, Idaho, 1911–12.
Wilson ditch near Ontario, Oreg., 1904–5.
Malheur River near Drewsey, Oreg., 1914.
Malheur River at Warmsprings reservoir site, near Riverside, Oreg., 1914–1917.
Malheur River above South Fork, at Riverside, Oreg., 1906–7; 1908–1910.
Malheur River at Riverside, Oreg., 1909–1915.
Malheur River near Namorf, Oreg., 1913–1917.
Malheur River near Harper ranch, near Westfall, Oreg., 1903–1905.
Malheur River near Little Valley, Oreg., 1914.
Malheur River at McLaughlin bridge, near Vale, Oreg., 1904–1906.
Malheur River at Vale, Oreg., 1890–91; 1895–96; 1903–1914.
Malheur River at Halliday bridge, near Ontario, Oreg., 1904–5.
Malheur River near Ontario, Oreg., 1903–4.
South Fork of Malheur River at Riverside, Oreg., 1910–1913; 1913–1915.
North Fork of Malheur River at Scotts ranch, near Beulah, Oreg., 1914.
North Fork of Malheur River at Foley's ranch, near Buelah, Oreg., 1909–1912; 1913–14.
Vines ditch near Little Valley, Oreg., 1904–5; 1914.
Malheur Farmers' canal above Vale, Oreg., 1904–5.
McLaughlin ditch above Vale, Oreg., 1904–5.
"J. H." ditch above Vale, Oreg., 1904–5.
Gellerman & Frohman ditch above Vale, Oreg., 1904–5.
Sand Hollow ditch above Vale, Oreg., 1904–5.
Bully Creek near Westfall, Oreg., 1911; 1912–13.

Digitized by Google

Columbia River tributaries—Continued.
Snake River tributaries—Continued.
Malheur River tributaries—Continued.
Bully Creek at Warm Springs, near Vale, Oreg., 1903–4; 1905–1907; 1911–1917.
Bully Creek at Vale, Oreg., 1904–5.
Hope Mill ditch at Vale, Oreg., 1904–5.
Willow Creek near Malheur, Oreg., 1904–1906; 1910–11; 1912–1915.
Willow Creek near Brogan, Oreg., 1912–1914.
Willow Creek at Dell, Oreg., 1904–1906; 1910–11.
Cow Creek near Brogan, Oreg., 1912–1914.
Pole Creek near Brogan, Oreg., 1912–13.
Nevada ditch below Vale, Oreg., 1904–5.
Payette River near Horseshoe Bend, Idaho, 1906–1916.
Payette River at Payette, Idaho, 1895–1897.
North Fork of Payette River at Lardo, Idaho, 1908–1917.
North Fork of Payette River at Van Wyck, Idaho, 1912–1916.
Lake Fork of Payette River near McCall, Idaho, 1909–1914.
Shafer Creek near Horseshoe Bend, Idaho, 1911–12.
Harris Creek near Horseshoe Bend, Idaho, 1911–12.
Weiser River near Weiser, Idaho, 1890–91; 1894–1904; 1910–1915.
Weiser River, West Fork, near Fruitvale, Idaho, 1910–1913.
Lost Creek near Tamarack, Idaho, 1910–1914.
Middle Fork of Weiser River at Middle Fork, Idaho, 1910–1913.
Sage Creek near Midvale, Idaho, 1913.
Sommercamp Creek near Midvale, Idaho, 1913.
Miller Creek near Midvale, Idaho, 1913.
Crane Creek near Midvale, Idaho, 1910–1916.
Mann Creek near Weiser, Idaho, 1911–1913.
Monroe Creek (upper station) near Weiser, Idaho, 1911–12.
Monroe Creek (lower station) near Weiser, Idaho, 1911–1913.
Burnt River, North Fork (head of Burnt River) near Audrey, Oreg., 1915–16.
Burnt River near Hereford, Oreg., 1915–16.
Burnt River near Bridgeport, Oreg., 1915–16.
Middle Fork of Burnt River near Audrey, Oreg., 1915–16.
South Fork of Burnt River near Unity, Oreg., 1915–16.
South Fork of Burnt River at Hardman ranch near Unity, Oreg., 1916–
Sawmill Creek near Unity, Oreg., 1915.
Camp Creek near Hereford, Oreg., 1915.
Powder River at Salisbury, Oreg., 1903–1914.
Powder River at Baker, Oreg., 1913; 1914.
Powder River near North Powder, Oreg., 1909–1912; 1913–1916.
Baldock Slough at Baker, Oreg., 1913; 1914.
Old Settlers Slough at Baker, Oreg., 1913; 1914.
Pine Creek near Baker, Oreg., 1913; 1914.
Goodrich Creek near Baker, Oreg., 1913.
Mill Creek near Baker, Oreg., 1913; 1914.
Lee-Polly ditch near Baker, Oreg., 1914.
Marble Creek near Baker, Oreg., 1913; 1914.
Salmon Creek near Baker, Oreg., 1913; 1914.
Willow Creek near Haines, Oreg., 1913.
North Powder River at Gardner's ranch, near North Powder, Oreg., 1912.
North Powder River at North Powder, Oreg., 1912; 1913; 1914.
Anthony Creek near North Powder, Oreg., 1912.

Digitized by Google

Columbia River tributaries—Continued.
Snake River tributaries—Continued.
Powder River tributaries—Continued.
Wolf Creek near North Powder, Oreg., 1913; 1914.
Big Creek near Medical Springs, Oreg., 1913; 1914.
Goose Creek near Keating, Oreg., 1913; 1914.
Eagle Creek above West Fork, near Baker, Oreg., 1911.
Eagle Creek near Baker, Oreg., 1909–10.
Eagle Creek near New Bridge, Oreg., 1910–11; 1914.
West Fork of Eagle Creek near Baker, Oreg., 1911.
Daly Creek, near Richland, Oreg., 1913.
Salmon River near Pierson, Idaho, 1911–1913.
Salmon River at Salmon, Idaho, 1912–1916.
Salmon River at Whitebird, Idaho, 1910–1917.
Lake Creek near Stanley, Idaho, 1910–1913.
Valley Creek near Stanley, Idaho, 1910–1913.
Pahsimeroi River near Goldburg, Idaho, 1910–1913.
Pahsimeroi River below the sinks, near Goldburg, Idaho, 1913.
Goldburg Creek near Goldburg, Idaho, 1910–1913.
Big Creek near Patterson, Idaho, 1910–1913.
Lemhi River:
Timber Creek near Leadore, Idaho, 1912.
West Fork of Timber Creek near Leadore, Idaho, 1912.
Eightmile Creek near Leadore, Idaho, 1912.
North Fork of Salmon River near North Fork, Idaho, 1912.
Grande Ronde River at Hilgard, Oreg., 1903–1915.
Grande Ronde River at Elgin, Oreg., 1903–1912.
Grande Ronde River at Zindel, Wash., 1904–1912.
Catherine Creek near Union, Oreg., 1906–7; 1911–12; 1915.
Little Creek near Union, Oreg., 1915.
Mill Creek near Summerville, Oreg., 1914–15.
Wallowa Lake (on Wallowa River) near Joseph, Oreg., 1905–6; 1912–1914; 1915.
Wallowa River at Joseph, Oreg., 1903–1914; 1915.
Wallowa River near Wallowa, Oreg., 1903–1907.
Wallowa River at Minam (near Elgin), Oreg., 1903–1914.
Silver Lake ditch near Joseph, Oreg., 1905; 1915.
Farmers and Citizens' ditch near Joseph, Oreg., 1905; 1915.
Granger ditch at Joseph, Oreg., 1905; 1915.
Big Bend ditch at Joseph, Oreg., 1905; 1915.
Hurricane Creek near Joseph, Oreg., 1915.
Lostine River near Lostine, Oreg., 1912–1914; 1915.
Company ditch near Wallowa, Oreg., 1905.
Bear Creek near Wallowa, Oreg., 1915.
Minam River at Minam, Oreg., 1912–1914.
Asotin Creek near Shelmans ranch, near Asotin, Wash., 1904–1906.
Asotin Creek near Asotin, Wash., 1904–5; 1910; 1911.
Selway River (head of Clearwater River), near Lowell, Idaho, 1911–12.
Clearwater River at Kamiah, Idaho, 1910–1916.
Clearwater River at Lewiston, Idaho, 1910–1913.
Lochsa River near Lowell, Idaho, 1910–1912.
South Fork of Clearwater River near Geangeville, Idaho, 1910–1916.
South Fork of Clearwater River at Kooskia, Idaho, 1910–1912.
Lolo Creek near Greer, Idaho, 1911–12.

Digitized by Google

Columbia River tributaries—Continued.
Tucannon River near Pomeroy, Wash., 1913–1915.
Tucannon River near Starbuck, Wash., 1914–1917.
Palouse River near Potlatch, Idaho, 1914–
Palouse River at Elberton, Wash., 1904–5.
Palouse River near Winona, Wash., 1915–1917.
Palouse River at Hooper, Wash., 1897–1916.
Rock Creek near Ewan (St. John), Wash., 1903–1905; 1914–1917.
Cow Creek near Keystone, Wash., 1904–5.
Cow Creek near Hooper, Wash., 1904.
Walla Walla River near Milton, Oreg., 1903–1908.
Walla Walla River at Whitman, Wash., 1897–1899.
South Fork of Walla Walla River near Milton, Oreg., 1906; 1907–1917.
South Fork of Walla Walla River near Milton, Oreg. (lower station), 1903–1906.
Mill Creek near Walla Walla, Wash., 1913–1917.
Umatilla River at Gibbon, Oreg., 1896–1911.
Umatilla River at Pendleton, Oreg., 1891–92; 1903–1905.
Umatilla River above Furnish reservoir, near Yoakum, Oreg., 1915–
Umatilla River at Yoakum, Oreg., 1903–1916.
Umatilla River near Umatilla, Oreg., 1903–
North Fork of Umatilla River near Gibbon, Oreg., 1912–1915.
McKay Creek near Pendleton, Oreg., 1903–4.
Farmers' mill ditch at Pendleton, Oreg., 1905.
Slusher & Gould ditch near Nolin, Oreg., 1905–6.
Lisle & Crane ditch near Echo, Oreg., 1905.
Charles Lisle ditch at Echo, Oreg., 1905–6.
Henrietta mill ditch at Echo, Oreg., 1905–6.
Wilson & Co.'s ditch at Echo, Oreg., 1905–6.
Allen ditch at Echo, Oreg., 1905–6.
Western Land & Irrigation Co.'s (Hinkle) ditch at Echo, Oreg., 1905–6.
Pioneer ditch at Echo, Oreg., 1905–6.
Maxwell ditch at Echo, Oreg., 1905–6.
Maxwell Land & Irrigation Co.'s (Hermiston) ditch near Hermiston, Oreg., 1905–6.
Beitle ditch near Hermiston, Oreg., 1905–6.
Oregon Land & Water Co.'s ditch at Umatilla, Oreg., 1905–6.
Brownell ditch at Umatilla, Oreg., 1905–6.
Willow Creek near Arlington, Oreg., 1905–6.
Rock Creek near Goldendale, Wash., 1911–1913.
Squaw Creek near Goldendale, Wash., 1911–1913.
John Day River near Prairie City, Oreg., 1916–17.
John Day River near Dayville, Oreg., 1908–1914.
John Day River at Clarno, Oreg., 1914–15.
John Day River at McDonald, Oreg., 1904–
Strawberry Creek near Prairie City, Oreg., 1916–17.
South Fork of John Day River at Dayville, Oreg., 1908–1914.
Dayville ditch at Dayville, Oreg., 1910–1914.
North Fork of John Day River:
Desolation Creek near Dale, Oreg., 1915–1917.
Camas Creek above Cable Creek, near Ukiah, Oreg., 1914–1917.
Camas Creek below Cable Creek, near Ukiah, Oreg., 1914.
Cable Creek near Ukiah, Oreg., 1914–1917.
Rock Creek at Rockcreek, Oreg., 1905; 1911.

Digitized by Google

Columbia River tributaries—Continued.
- Deschutes River at Crane Prairie, near Lapine, Oreg., 1907–1913; 1914–1917.
- Deschutes River at Forest Service bridge, near Lapine, Oreg., 1910; 1912; 1913; 1914—1917.
- Deschutes River near Lava, Oreg., 1905–1907; 1909–1911; 1912; 1913–1915.
- Deschutes River at West's ranch, near Lava, Oreg., 1906–1909; 1914.
- Deschutes River at Benham Falls, Oreg., 1909–1914.
- Deschutes River at Lava Island, Oreg., 1915–16.
- Deschutes River at Bend, Oreg., 1904–1914.
- Deschutes River below Bend, Oreg., 1914–
- Deschutes River at Tumalo [Laidlaw], Oreg., 1909–1912; 1914–15.
- Deschutes River near Cline Falls, Oreg., 1910–11; 1912–13.
- Deschutes River at Mecca, Oreg., 1911–
- Deschutes River at Sherar, Oreg., 1912–1914.
- Deschutes River at Moro, Oreg., 1897–1899.
- Deschutes River at Moody (Biggs), Oreg., 1906–
  - Odell Creek near Crescent, Oreg., 1911; 1912; 1913; 1914.
  - Fall River near Lapine, Oreg., 1912.
  - East Fork at Crescent, Oreg., 1904–1908; 1910–1914.
  - East Fork at Morson intake, near Lapine, Oreg., 1914–1917.
  - East Fork near Lapine, Oreg., 1910–1913.
  - East Fork at Allen's ranch, near Lava, Oreg., 1905–1912; 1913–1915.
    - Crescent Creek at outlet of Crescent Lake, near Crescent, Oreg., 1911; 1912–1915.
    - Crescent Creek below Cold Creek, near Crescent, Oreg., 1912–13.
    - Crescent Creek near Crescent, Oreg., 1912–13; 1914.
    - Big Marsh Creek near Crescent, Oreg., 1912–1914.
  - Arnold Canal near Bend, Oreg., 1914–
  - Central Oregon canal near Bend, Oreg., 1905–
  - Pilot Butte canal near Bend, Oreg., 1905–
  - North canal near Bend, Oreg., 1913–
  - Swalley canal near Bend, Oreg., 1913–
  - Tumalo Creek near Tumalo [Laidlaw], Oreg., 1906–1914.
  - Tumalo Creek near Bend, Oreg., 1906–
    - Lewis Creek near Tumalo [Laidlaw], Oreg., 1908–9.
    - Wimer canal near Tumalo [Laidlaw], Oreg., 1906–1914; 1916–17.
    - Columbia Southern canal near Tumalo [Laidlaw], Oreg., 1906–1914; 1916.
    - Tumalo feed canal near Bend, Oreg., 1914–
  - Squaw Creek near Sisters, Oreg., 1906–
    - Squaw Creek canal near Sisters, Oreg., 1916–
    - McAllister's ditch near Sisters, Oreg., 1909–1913.
  - Crooked River near Post, Oreg., 1908–1911.
  - Crooked River at Hoffman's ranch, near Prineville, Oreg., 1913–14.
  - Crooked River near Prineville, Oreg., 1908–1912.
  - Crooked River at Prineville, Oreg., 1914.
    - Prineville flour mill tailrace at Prineville, Oreg., 1914.
    - Ochoco Creek near Howard, Oreg., 1910–11.
    - Ochoco Creek at Elliot's ranch, near Prineville, Oreg., 1908–1910; 1914–
    - Ochoco Creek at Prineville, Oreg., 1912; 1913–1915.
      - Marks Creek near Prineville, Oreg., 1916.
      - Mill Creek near Prineville, Oreg., 1916.
      - Tableland ditch near Prineville, Oreg., 1915–1917.
      - Elliot ditch near Prineville, Oreg., 1908–1910; 1914–1917.
    - McKay Creek near Prineville, Oreg., 1915–16.

Digitized by Google

Columbia River tributaries—Continued.
Deschutes River tributaries—Continued.
Metolius River at Alligham ranger station, near Sisters, Oreg., 1910–1913; 1915–1917.
Metolius River at Hubbard's ranch, near Grandview, Oreg., 1910–1913.
Metolius River at Riggs ranch, near Sisters, Oreg., 1908–1912.
Lake Creek near Sisters, Oreg., 1911–1913; 1915–
First Creek near Sisters, Oreg., 1915–1917.
Jack Creek near Sisters, Oreg., 1915–16.
Canyon Creek near Sisters, Oreg., 1915–16.
Whitewater River near Grandview, Oreg., 1911–1913.
Shitike Creek at Warmspring, Oreg., 1911–1916.
Trout Creek near Antelope, Oreg., 1915; 1916–17.
Trout Creek near Gateway, Oreg., 1915; 1916.
Hay Creek near Hay Creek, Oreg., 1915; 1916.
Warm Springs River near Warmspring, Oreg., 1911–
Mill Creek near Warmspring, Oreg., 1915.
White River near Tygh Valley, Oreg., 1911–
Tygh Creek at Tygh Valley, Oreg., 1911–1913.
Klickitat River above Pearl Creek, near Glenwood, Wash., 1910; 1916.
Klickitat River above Big Muddy Creek, Wash., 1905.
Klickitat River below Big Muddy Creek, Wash., 1905; 1907–8.
Klickitat River at Camp Klickitat, Wash., 1907–8.
Klickitat River near Glenwood, Wash., 1909–
Klickitat River below Glenwood, Wash., 1914.
Klickitat River at Hanson's cable, near Klickitat, Wash., 1908–9.
Klickitat River at Klickitat (Wright), Wash., 1909–1912.
Klickitat River at Wols Ferry, near Lyle, Wash., 1907–1910.
Klickitat River near Lyle, Wash., 1912.
Pearl Creek near Glenwood, Wash., 1916.
Swamp Creek near Glenwood, Wash., 1916.
West Fork of Klickitat River near Glenwood, Wash., 1910; 1916.
Surveyors Creek near Glenwood, Wash., 1916.
Cunningham Creek near Glenwood, Wash., 1916.
Big Muddy Creek near Glenwood, Wash., 1916–
Big Muddy River above mouth of Cougar Creek, near Wright, Wash., 1905; 1908.
Cougar Creek near Glenwood, Wash., 1916.
Little Klickitat River near Goldendale, Wash., 1910–1912.
Hood River at Dee, Oreg., 1913–1917.
Hood River at Winans, Oreg., 1905–1907; 1910–1912; 1913.
Hood River at Tucker Bridge, Oreg., 1897–1899; 1913–1917.
Hood River at Powerdale, near Hood River, Oreg., 1913–
East Fork of Hood River near Mount Hood, Oreg., 1913.
East Fork Hood River near Dee, Oreg., 1917.
East Fork Irrigation District canal near Mount Hood, Oreg., 1913–
West Fork of Hood River near Dee, Oreg., 1913–1916.
Pacific Light & Power Co.'s tailrace near Hood River, Oreg., 1914; 1916–
White Salmon River at splash dam near Trout Lake, Wash., 1912–1917.
White Salmon River at Husum, Wash., 1909–
White Salmon River at Condit dam, near Underwood, Wash., 1912–13.
White Salmon River near Underwood, Wash., 1915–
Trout Creek at Guler, Wash., 1909–1911.

Digitized by Google

Columbia River tributaries—Continued.
- Little White Salmon River below Lava Creek, near Cook, Wash., 1903–1906.[1]
- Little White Salmon River near Cook, Wash., 1909.
- Latourell Creek at Latourell, Oreg., 1912–13.
- Sandy River above Salmon River, at Brightwood, Oreg., 1910–1914.
- Sandy River below Salmon River, near Brightwood, Oreg., 1907–1911.
- Sandy River near Marmot, Oreg., 1911–1915.
- Sandy River at and below dam near Marmot, Oreg., 1915–
- Sandy River above Bull Run River, near Bull Run, Oreg., 1910–1912.
- Sandy River below Bull Run River, near Bull Run, Oreg., 1910–1914.
  - Clear Fork of Sandy River near Welches, Oreg., 1913; 1914–15.
  - Lost Creek near Brightwood, Oreg., 1913–
  - Sandy River canal near Marmot, Oreg., 1916–
  - Still Creek near Rowe, Oreg., 1910–1912.
  - Salmon River near Rowe, Oreg., 1910–1912.
  - Salmon River at Welches, Oreg., 1913–14.
  - Salmon River at Fish Hatchery, near Brightwood, Oreg., 1912–13.
  - Bull Run River near Bull Run, Oreg., 1895–
    - Little Sandy River near Marmot, Oreg., 1913–
    - Little Sandy River near Bull Run, Oreg., 1911–1913.
      - Little Sandy flume near Bull Run, Oreg., 1912–13.
- Willamette River, Middle Fork (head of Willamette River), above Salt Creek, near Oakridge, Oreg., 1913–14.
- Willamette River, Middle Fork, below North Fork, near Oakridge, Oreg., 1911–12.
- Willamette River, Middle Fork, at Jasper, Oreg., 1905–1912; 1913–1917.
- Willamette River at Springfield, Oreg., 1911–1913.
- Willamette River at Albany, Oreg., 1878–1880; 1892–
- Willamette River at Salem, Oreg., 1909–1916.
- Willamette River at Oregon City, Oreg., 1909–1912.
  - Salt Creek near Oakridge, Oreg., 1913–14.
  - Salmon Creek near Oakridge, Oreg., 1913–
  - North Fork of Middle Fork of Willamette River near Oakridge (Hazeldell), Oreg., 1909–1912; 1913–1916.
  - Fall Creek near Fall Creek, Oreg., 1911.
  - Coast Fork of Willamette River near Goshen, Oreg., 1905–1912.
    - Row River near Disston, Oreg., 1910–1913.
  - McKenzie River at Clear Lake, Oreg., 1912–1915.
  - McKenzie River at McKenzie Bridge, Oreg., 1910–
  - McKenzie River at Martins Rapids, Oreg., 1910–11.
  - McKenzie River near Springfield, Oreg., 1905–1915.
    - Eugene power canal near Walterville, Oreg., 1912–1915.
  - North Santiam River near Hoover, Oreg., 1910–1913.
  - North Santiam River at Detroit, Oreg., 1907–1909.
  - North Santiam River at Niagara, Oreg., 1908–
  - North Santiam River at Mehama, Oreg., 1905–1907; 1910–1914.
  - Santiam River at Jefferson, Oreg., 1905–6; 1908–1916.
    - Marion Fork of Santiam River at Marion Lake, near Hoover, Oreg., 1907; 1909–1912.
    - Puzzle Creek near Detroit (Hoover), Oreg., 1907; 1909.
      - North Fork of Puzzle Creek near Hoover, Oreg., 1909–1912.
      - South Fork of Puzzle Creek near Hoover, Oreg., 1909–1912.
    - Pamelia Creek near Detroit, Oreg., 1907; 1909; 1913.

[1] Records published in U. S. Geol. Survey Water-Supply Paper 272, pp. 428–429.

Digitized by Google

Columbia River tributaries—Continued.
- Willamette River tributaries—Continued.
  - Santiam River tributaries—Continued.
    - Whitewater Creek near Detroit, Oreg., 1907; 1913.
    - Breitenbush Creek near Detroit, Oreg., 1910–1913.
    - South Santiam River near Cascadia, Oreg., 1910–1913.
    - South Santiam River near Foster, Oreg., 1911.
    - South Santiam River at Waterloo, Oreg., 1905–1907; 1910–11.
      - Middle Santiam River near Foster, Oreg., 1911.
  - Luckiamute River near Suver, Oreg., 1905–1911.
  - Yamhill River, South Fork (head of Yamhill River), at Sheridan, Oreg., 1906–1911.
  - Yamhill River at La Fayette, Oreg., 1908–1914.
  - Molalla River near Molalla, Oreg., 1905–1909.
  - Clackamas River near Cazadero, Oreg., 1909–
  - Clackamas River at Estacada, Oreg., 1908–1911.
  - Clackamas River near Barton, Oreg. (replaced by Estacada station), 1905–1908.
  - Clackamas River at Park Place, Oreg., 1911–12.
    - Oak Grove Fork of Clackamas River at Timothy Meadows, near Cazadero, Oreg., 1913–1916.
    - Oak Grove Fork of Clackamas River at intake, near Cazadero, Oreg., 1909–
- Lewis River above Muddy River near Cougar, Wash., 1909.
- Lewis River near Cougar, Wash., 1909–1912.
- Lewis River near Amboy, Wash., 1911–
- Lewis River at Ariel, Wash., 1909.
  - Muddy River at mouth, near Cougar, Wash., 1909.
  - Pine Creek at mouth, near Cougar, Wash., 1909.
  - Swift Creek at mouth, near Cougar, Wash., 1909.
- Kalama River near Kalama, Wash., 1911–1913; 1916–
- Ohanapecosh River near Lewis, Wash., 1907–1917.
- Cowlitz River at Lewis, Wash., 1911–
- Cowlitz River at Randle, Wash., 1910–1912.
- Cowlitz River at Mossy Rock, Wash., 1912–1917.
- Cowlitz River at Mayfield, Wash., 1910–11.
  - Clear Fork near Lewis, Wash., 1907–1917.
  - Coal Creek near Lewis, Wash., 1910–1915.
  - Lake Creek at outlet of Packwood Lake, near Lewis, Wash., 1911–
  - Lake Creek at mouth, near Lewis, Wash., 1907–1915.
  - Hagar Creek near Lewis, Wash., 1911–12; 1913–14.
    - North Fork of Hagar Creek near Lewis, Wash., 1911–12; 1913–14.
  - Johnson Creek below West Fork, near Lewis, Wash., 1911–1914.
  - Johnson Creek at mouth, near Lewis, Wash., 1907–1914.
  - Glacier Creek near Lewis, Wash., 1911–1914.
  - Cispus River near Randle, Wash., 1910–1912.
  - Toutle River at St. Helens, Wash., 1909.
  - Toutle River near Castle Rock, Wash., 1909–1912.
- Youngs River near Astoria, Oreg., 1916–

STREAMS BETWEEN COLUMBIA RIVER AND KLAMATH RIVER.

Rogue River near Prospect, Oreg., 1907–1912.
Rogue River below Prospect, Oreg., 1913–
Rogue River near Trail, Oreg., 1910–1913.

Digitized by Google

Rogue River near Tolo, Oreg., 1905–
Rogue River near Galice, Oreg., 1906.
California-Oregon Power Co.'s flume near Prospect, Oreg., 1913–
Mill Creek near Prospect, Oreg., 1910.
Big Butte Creek, South Fork (head of Big Butte Creek), at Butte Falls, Oreg., 1910–11; 1915.
Little Butte Creek, South Fork (head of Little Butte Creek), near Deadwood, Oreg., 1917.
Little Butte Creek, South Fork, near Lake Creek, Oreg., 1910–1913.
Little Butte Creek above Eagle Point, Oreg., 1916–
Little Butte Creek near Eagle Point, Oreg., 1907–1916.
Dead Indian Creek near Lilyglen, Oreg., 1916–
North Fork of Little Butte Creek, near Lake Creek, Oreg., 1911–1913; 1916–
Rogue River Valley canal at intake, near Lake Creek, Oreg., 1914; 1915; 1916.
Rogue River Valley canal near Brownsboro, Oreg., 1913; 1915–
Bear Creek at Talent, Oreg., 1907–1914.
Bear Creek at Medford, Oreg., 1915–
Neil Creek near Ashland, Oreg., 1913.
George Dunn ditch near Ashland, Oreg., 1913.
Ashland Creek at Ashland, Oreg., 1913.
Wagner Creek near Talent, Oreg., 1913.
Phoenix ditch near Talent, Oreg., 1916–
Evans Creek at Wimer, Oreg., 1913.
Applegate River near Buncom, Oreg., 1911–1914.
Applegate River at Murphy, Oreg., 1907–1910.
Cameron ditch near Buncom, Oreg., 1911–1914.
East Fork of Little Applegate River near Buncom, Oreg., 1913.
Little Applegate River near Ruch, Oreg., 1913.
West Fork of Little Applegate River near Buncom, Oreg., 1913.
Spicer ditch near Buncom, Oreg., 1913.
Thompson Creek near Applegate, Oreg., 1913.
Slate Creek at Wonder, Oreg., 1913.
Grave Creek near Placer, Oreg., 1913.
Coquille River, South Fork, at Powers, Oreg., 1916–
South Umpqua River (head of Umpqua River) near Tiller, Oreg., 1910–11.
South Umpqua River near Brockway, Oreg., 1905–1912.
Umpqua River near Elkton, Oreg., 1905–
Cow Creek at Riddle, Oreg., 1911–12.
North Umpqua River at Tokeetee Falls near Hoaglin, Oreg., 1908–9; 1914–1917.
North Umpqua River near Hoaglin, Oreg., 1910–1912; 1914–1916.
North Umpqua River near Glide, Oreg., 1915–
North Umpqua River near Oakcreek, Oreg., 1905–1908; 1913–1915.
North Umpqua River at Winchester, Oreg., 1908–1913.
Calapooya Creek near Sutherlin, Oreg., 1912–13.
Luse canal near Sutherlin, Oreg., 1912–13.
Mill Creek near Ash, Oreg., 1907–1912; 1915–1917.
Siletz River at Siletz, Oreg., 1905–1912.
Wilson River near Tillamook, Oreg., 1914–1916.
North Fork of Wilson River near Tillamook, Oreg., 1913–1915; 1916.
Nehalem River at Salmonberry, near Balm, Oreg., 1913–14.

Digitized by Google

REPORTS ON WATER RESOURCES OF THE NORTH PACIFIC SLOPE DRAINAGE BASINS.

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

WATER-SUPPLY PAPERS.

Water-supply papers are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers marked in this way may, however, be purchased (at price noted) from the SUPERINTENDENT OF DOCUMENTS, Washington, D. C. Omission of the price indicates that the report is not obtainable from Government sources. Water-supply papers are of octavo size.

*4. A reconnaissance in Southeastern Washington, by I. C. Russell, 1897. 96 pp., 7 pls. 15c.

Describes an area "bordered on the south by Oregon, on the east by Idaho, on the north by Snake River, and on the west by the Columbia," and "briefly designated as lying south of Snake River," discusses climate, vegetation, topography and drainage, geologic formations—including the river terraces and soils—irrigation, and the artesian water supply, and gives an outline of the geological history of the region.

*44. Profiles of rivers in the United States, by Henry Gannett. 1901. 100 pp. 11 pls. 15c.

Gives elevations and distances along Columbia, Willamette, Flathead, and Snake rivers.

*53. Geology and water resources of Nez Perce County, Idaho, Part I, by I. C. Russell. 1901. 85 pp., 10 pls. 10c.

*54. Geology and water resources of Nez Perce County, Idaho, Part II, by I. C. Russell. 1901. 55 pp. (87–141).

Nos. 53 and 54 relate to an area "in western Idaho, bordered on the west by portions of Washington and Oregon," drained through Snake River to the Columbia; they describe the topography, geology, and soils of the region, discuss the relation of the surface features—plateaus, canyons, streams, etc.—to the geology and the climate, the source and quantity of the water supply, including springs and artesian wells, and refer briefly to the occurrence of building stones, lignite, gold, silver, and copper. They include also a short bibliography of artesian waters and two appendixes—one giving list of elevations, and the other notes concerning Portland cement.

55. Geology and water resources of a portion of Yakima County, Wash., by G. O. Smith. 1901. 68 pp., 7 pls. 10c.

Describes topography, climate, soil, agriculture, geology, and surface and ground waters of an area comprising about 50 square miles in the vicinity of North Yakima; discusses in some detail the artesian basins and wells.

*57. Preliminary list of deep borings in the United States, Part I (Alabama-Montana), by N. H. Darton. 1902. 60 pp. 5c.

*61. Preliminary list of deep borings in the United States, Part II, (Nebraska-Wyoming), by N. H. Darton. 1902. 67 pp. 5c.

Nos. 57 and 61 contain information as to depth, diameter, yield, and head of water in borings more than 400 feet deep; under head "Remarks" gives information concerning temperature, quality of water, purposes of boring, etc. The lists are arranged by States, and the States are arranged alphabetically. A second, revised, edition was published in 1905 as Water-Supply Paper 149 (q. v.). 5c.

*78. Preliminary report on artesian basins in southwestern Idaho and southeastern Oregon, by I. C. Russell. 1903. 53 pp., 2 pls. 5c.

Discusses briefly the rocks and geologic structure of a part of the Snake River Plains in Canyon and Owyhee counties, Idaho, and Malheur and Harney counties, Oreg.; describes briefly the conditions on which artesian flow depends, and in some detail the springs and drilled wells in the Lewis, Otis, Harney, and Whitehorse artesian basins; also describes artesian wells in alluvial deposits and discusses the size of drill holes, casings, etc., the preservation of well records, and the importance of laws to control the use of artesian waters; gives list of publications bearing on artesian waters.

Digitized by Google

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer, 1904. 361 pp. 25c. [Inquiries concerning this report should be addressed to the Reclamation Service.] Contains:

Investigations in Idaho, by D. W. Ross. Describes the irrigable lands in the area drained by Snake River.

Investigations in Oregon, by J. T. Whistler. Mentions the Umatilla, Malheur, and Harney projects.

Work in Washington, by T. A. Noble. Describes the plains of Columbia River.

96. Destructive floods in the United States in 1903, by E. C. Murphy. 1904. 81 pp., 13 pls. 15c.

Gives an account of a flood (commonly spoken of as the "Heppner disaster") on Willow Creek, a tributary of Columbia River, in Morrow County, Oreg.

*103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. [Superseded by No. 152, q. v.]

Cites statutory restrictions of water pollution in Idaho, Nevada, Oregon, Utah, Washington, and Wyoming.

111. Preliminary report on the underground waters of Washington, by Henry Landes. 1905. 85 pp., 1 pl. 10c.

Describes, by counties, the municipal water supplies, deep wells, and springs in the State, giving also for each county a brief account of the climate, rainfall, topography, drainage, and geology.

118. Geology and water resources of a portion of east-central Washington, by F. C. Calkins. 1905. 96 pp., 4 pls. 5c.

Describes briefly the topography, geology, climate, vegetation, grazing, and agriculture on the Columbia Plains and in Kittitas Valley; discusses the streams, springs, and shallow and deep wells.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

Cites legislative acts relating to ground waters in Idaho, Nevada, Oregon, Utah, Washington, and Wyoming.

*149. Preliminary list of deep borings in the United States, second edition, with additions, by N. H. Darton. 1905. 175 pp. 10c.

Gives, by States (and within the States by counties), location, depth, diameter, yield, height of water, and other available information, concerning wells 400 feet or more in depth; includes all wells listed in Water-Supply Papers 57 and 61; mentions also principal publications relating to deep borings.

*152. A review of the laws forbidding pollution of inland waters in the United States (second edition), by E. B. Goodell. 1905. 149 pp. 10c.

Cites statutory restrictions of water pollution in Idaho, Nevada, Oregon, Utah, Washington, and Wyoming.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

Gives estimates (p. 85) of flood discharge and frequency for Boise River at Boise and Weiser River at Weiser, Idaho.

*231. Geology and water resources of the Harney Basin region, Oregon, by G. A. Waring. 1909. 93 pp., 5 pls. 25c.

The greater part of the area covered by this report is in the Great Basin, but a small tract in the northeastern corner is drained by a number of small streams that are tributary to Malheur River.

253. Water powers of the Cascade Range, Part I, Southern Washington, by J. C. Stevens. 1910. 94 pp., 21 pls. 40c.

Discusses conditions governing hydraulic development, water laws of Washington, and variations in streams; describes the drainage basins of Klickitat, White Salmon, Little White Salmon, Lewis, and Toutle rivers; gives results of observations at gaging stations, and estimates of average minimum discharge and of the available horsepower at the power sites.

99664°—20—WSP 464——12

Digitized by Google

274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pp. 15c.

Describes collection of samples, plan of analytical work, and methods of analyses; discusses soap-consuming power of waters, water softening, boiler waters, and water for irrigation; gives results of analyses of waters of Boise, Malheur, Payette, and Palouse rivers, and Salmon Creek.

313. Water powers of the Cascade Range, Part II, Cowlitz, Nisqually, Puyallup, White, Green, and Cedar drainage basins, by F. F. Henshaw and G. L. Parker. 1913. 170 pp., 16 pls. 55c.

Describes the geological features and history of the drainage basins, topography and drainage, soils and vegetation, and precipitation; gives stream-flow records and discusses water powers, storage, and power sites; discusses also natural resources and harbors of the Pacific coast, central electric stations, and power utilization, and gives commercial and residential rates. See also 253.

316. Geology and water resources of a portion of south-central Washington, by G. A. Waring. 1913. 46 pp., 1 pl. 5c.

Describes settlements, climate and vegetation, agriculture, grazing, geographic provinces, relation of surface features and structure, and geology; discusses shallow and artesian waters and irrigation enterprises in Sunnyside and Reservation valleys, Horse Heaven Plateau, and the Columbia River Plains, and irrigation along lower Yakima River; gives tabulated data concerning wells and springs.

*339. Quality of the surface waters of Washington, by Walton Van Winkle. 1914. 105 pp., 2 pls. 15c.

Discusses briefly the natural and economic features of the State, the constituents and uses of the natural waters, purification of water, methods of analysis, and industrial and geochemical interpretation of the results of analysis; describes the general features of the principal drainage basins and gives the results of an investigation of the character of the river waters; treats briefly of the average chemical composition of river water, the economic value of the rivers, denudation, and the influence of natural features on the character of the waters.

344. Deschutes River, Oregon, and its utilization, by F. F. Henshaw, John H. Lewis, and E. J. McCaustland. 1914. 200 pp., 28 pls. 50c.

A report, prepared in cooperation with the State of Oregon, containing the results of measurements of stream flow, a discussion of the economic distribution of the water, and chapters on the quality of the water, the availability of the water supply, the developed water powers, undeveloped power sites, water rights and appropriations, the relation of the Federal Government to the development of water power, and Government permits for power and reservoir sites.

346. Profile surveys in the basin of Clark Fork of Columbia River, Montana-Idaho-Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 6 pp., 3 pls. (22 sheets). 50c.

*347. Profile surveys in Snake River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1914. 12 pp., 3 pls. (37 sheets). 55c.

348. Profile surveys in Hood and Sandy River basins, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pp., 2 pls. (6 sheets). 30c.

349. Profile surveys in Willamette River basin, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pp., 3 pls. (16 sheets). 30c.

363. Quality of the surface waters of Oregon, by W. Van Winkle. 1914. 137 pp., 2 pls. 20c.

Describes the topography, drainage, rocks and soils, climate, population, and industries of the State, the constituents of natural waters, water for domestic and industrial uses, and purification of water, methods of analysis, and interpretation of results of analysis; describes the general features of the river basins and the character of the river waters, discusses the conditions influencing the quality of the surface waters, average chemical composition, geochemical character, denudation, industrial value, and value for irrigation.

Digitized by Google

*364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of Soap and Omak lakes, Wash., and of mine waters from Butte, Mont.

366. Profile surveys of Snoqualmie, Sultan, and Skykomish rivers, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pp., 3 pls. (12 sheets). 20c.

368. Profile surveys in Wenatchee River basin, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pp., 1 pl. (8 sheets). 20c.

369. Water powers of the Cascade Range, Part III, Yakima River basin, by G. L. Parker and F. B. Storey, 1916. 169 pp., 20 pls. 45c.

Describes the geography of the basin, the geologic history, physiography and river history, climate, settlement, and development, population, and transportation; gives stream-flow records and discusses natural conditions affecting stream flow; storage reservoirs, developed and undeveloped power sites; treats also of the industrial development of the region, discussing irrigation by gravity systems and by pumping, the production of coal and other minerals, and manufacturing; presents a scheme of development and utilization of stored water. The report was prepared under the direction of the Washington State Board of Geological Survey, and is based on data consisting of "stream-flow records, river plans and profiles, reservoir surveys, and field reconnaissance of the rivers and their various tributaries," obtained by the United States Geological Survey and the United States Reclamation Service, supplemented by a large amount of information furnished by private parties.

370. Surface water supply of Oregon, 1878–1910, by F. F. Henshaw and H. J. Dean. 1915. 829 pp., 1 pl. 45c.

Describes briefly the natural features of Oregon and in greater detail the general features of the river basins; consists principally of records of stream flow that have been carefully studied and recomputed when necessary to insure their best possible interpretation.

*376. Profile surveys in Chelan and Methow River basins, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1915. 8 pp., 5 pls. 15c.

377. Profile surveys in Spokane River basin, Washington, and John Day River basin, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pp., 10 pls. 15c.

378. Profile surveys in 1914 on Middle Fork of Willamette River and White River, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1915. 8 pp., 6 pls. 15c.

379. Profile surveys in 1914 in Umpqua River basin, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pp., 13 pls. 20c.

*400. Contributions to the hydrology of the United States, 1916, Nathan C. Grover, chief hydraulic engineer, 1917. 108 pp., 7 pls. 15c. Contains:

(*b*) Artesian water for irrigation in Little Bitterroot Valley, Mont., by O. E. Meinzer.

419. Profile surveys in 1915 in Skagit River basin, Washington, prepared under the direction of W. H. Herron, acting chief geographer. 1916. 8 pp., 12 pls. 15c.

420. Profile surveys along Henrys Fork, Idaho, and Logan River and Blacksmith Fork, Utah, prepared under the direction of W. H. Herron, acting chief geographer. 1916. 8 pp., 10 pls. 10c.

*425. Contributions to the hydrology of the United States, 1917, N. C. Grover, chief hydraulic engineer, 1918. Contains:

(*c*) Ground water in Quincy Valley, Wash., by A. T. Schwennesen and O. E. Meinzer.

Digitized by Google

BULLETINS.

An asterisk (*) indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers so marked may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Bulletins are of octavo size.

*199. Geology and water resources of the Snake River Plains of Idaho, by I. C. Russell. 1902. 192 pp., 25 pls. 25c.

Describes the topography, geology, climate, vegetation, fauna, and soils of an area extending entirely across the southern part of Idaho; discusses streams, springs, water powers, irrigation and agriculture, industries, and routes of transportation and highways; treats of the origin of surface and subsurface waters, the requisite conditions for artesian wells and the quantity of water available.

*252. Preliminary report on the geology and water resources of central Oregon, by I. C. Russell. 1905. 138 pp., 24 pls. 15c.

Describes a portion of the extreme northern part of the Great Basin and a part of the drainage area of Deschutes River and its principal tributary, Crooked River; gives an account of the topography, drainage, rainfall and temperature, winds, and forests; describes the volcanic sedimentary rock formations, and discusses by counties the geology and topography, the surface and ground waters; treats of artesian conditions in the Deschutes basin and makes suggestions concerning artesian well records.

*264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp. 10c.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 299 pp. 25c.

Bulletins 264 and 298 give an account of progress in the collection of well records and samples, and contain tabulated records of wells in Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. No. 298 gives detailed records of wells in Flathead County, Mont., and Benton, Jefferson, and Walla Walla counties, Wash. The wells of which detailed sections are given were selected because they afford valuable stratigraphic information.

ANNUAL REPORTS.

Each of the papers contained in the annual reports was also issued in separate form.

Annual reports are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers so marked, however, may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C.

*Tenth Annual Report of the Director of the United States Geological Survey, 1888–89, J. W. Powell, Director. 1890. 2 parts. *Pt. II. Irrigation, viii, 123 pp. 35c.

Makes a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation; includes an account of the methods of topographic and hydraulic work, the segregation work on reservoir sites and irrigable lands, field and office methods, and brief descriptions of the topography of some of the river basins.

Eleventh Annual Report of the United States Geological Survey, 1889–90, J. W. Powell, Director. 1891. 2 parts. Pt. II. Irrigation, xiv, 395 pp. 30 pls. and maps. $1.25. Contains:

*Hydrography, pp. 1–110. Discusses scope of work, methods of stream measurement, rainfall and evaporation, and describes the more important streams.

*Engineering, pp. 111–200. Defines the scope of the work and gives an account of the survey in the Sun River basin and in the Arkansas, Rio Grande, California, Lahontan, Utah, and Snake River divisions.

*Topography, pp. 291–343. Comprises reports of the topographic surveys in California, Nevada, Colorado, Idaho, Montana, and New Mexico, and a report on reservoir sites.

*Irrigation literature, pp. 345–388. Gives a list of books and pamphlets on irrigation and allied subjects, mainly contained in the library of the United States Geological Survey.

*Twelfth Annual Report of the Director of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xviii, 576 pp. 93 pls. $2. Contains:

*Hydrography of the arid regions, by F. H. Newell, pp. 213–361, Pls. 58–106. Discusses the availabe water supply of the arid regions, the duty of water, flood waters, relation of rainfall to river flow; classifies the drainage basins; and describes the rivers of the Missouri, Arkansas, Rio Grande, Colorado, Sacramento, and San Joaquin basins, and the principal streams of the Great Basin in Nevada and Utah and the Snake River basin.

Digitized by Google

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*Engineering results of irrigation survey, by H. M. Wilson, pp. 351–427, Pls. 147–182. Describes structures on the Pocatello canal, Idaho.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Charles D. Walcott, Director. 1896. (Pts. II, III, and IV, 1895.) 4 parts. *Pt. II. Papers of an economic character, xix, 598 pp., 43 pls. $1.25. Contains:

The public lands and their water supply, by F. H. Newell, pp. 457–533, Pls. 35–39. Describes general character of the public lands, the lands disposed of (railroad, grant, and swamp lands, and private miscellaneous entries), lands reserved (Indian, forest, and military reservations), the vacant lands, and the rate of disposal of vacant land; discusses the streams, wells, and reservoirs as sources of water supply; gives details for each State.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director. 1898. (Pts. II, III, and V, 1899.) 6 parts in 7 vols. and separate case for maps with Pt. V. *Pt. V, Forest reserves, xvii, 400 pp., 110 pls. $1.25. 16 maps in separate case, 75c. Contains:

*Priest River Forest Reserve, by J. B. Leiberg, pp. 217–252, Pls. 48–61.
*Bitterroot Forest Reserve, by J. B. Leiberg, pp. 253–282, Pls. 62–73.
*Washington Forest Reserve, by H. B. Ayres, pp. 283–313, Pls. 76–100.
*Eastern part of Washington Forest Reserve, by M. W. Gorman, pp. 315–350, Pl. 101.
*Forest conditions of northern Idaho, by J. B. Leiberg, pp. 373–386, Pls. 109–110.
These reports describe the topography and the streams of the forest reserves.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Charles D. Walcott, Director. 1899. (Pts. II, III, IV, V, and VII, 1900.) 7 parts in 8 vols. and separate case for maps with Pt. V. *Pt. V, Forest reserves, xix, 498 pp., 159 pls., 8 maps in separate case. $2.80. Contains:

*The Flathead Forest Reserve, by H. B. Ayres, pp. 245–316, Pls. 77–113.
*Bitterroot Forest Reserve, by J. B. Leiberg, pp. 317–409, Pls. 115–142. Contains brief descriptions of the streams and lakes in the reserves.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Charles D. Walcott, Director. 1900. (Pts. III, IV, VI, VI continued, and VII, 1901.) 7 parts in 8 vols. and separate case for maps with Pt. V. *Pt. V, Forest reserves, 711 pp., 143 pls., 39 maps in separate case. $3.85. Contains:

*Mount Rainier Forest Reserve, Washington, by F. G. Plummer, pp. 81–143, Pls. 33–50.
*Olympic Forest Reserve, Washington, from field notes by Arthur Dodwell and T. F. Rixon, pp. 145–208, Pls. 51–70.
*Cascade Range Forest Reserve, Oregon, from T. 28 S. to T. 37 S., inclusive, together with the Ashland Forest Reserve and adjacent forest regions from T. 28 S. to T. 41 S., inclusive, and from R. 2 W. to R. 14 E., Willamette meridian, inclusive, by J. B. Leiberg, pp. 209–498, Pls. 71–84.
Contains descriptions of many of the streams flowing through the forest reserves.

GEOLOGIC FOLIOS.

Under the plan adopted for the preparation of a geologic map of the United States the entire area is divided into small quadrangles, bounded by certain meridians and parallels, and these quadrangles, which number several thousand, are separately surveyed and mapped.[1] The unit of survey is also the unit of publication, and the maps and description of each quadrangle are issued in the form of a folio. When all the folios are completed they will constitute the Geologic Atlas of the United States.

A folio is designated by the name of the principal town or of a prominent natural feature within the quadrangle. Each folio includes maps showing the topography, geology, underground structure, and mineral deposits of the area mapped and several pages of descriptive text. The text explains the maps and describes the topographic

[1] Index maps showing areas in the North Pacific slope basins covered by topographic maps and by geologic folios will be mailed on receipt of request addressed to the Director, U. S. Geological Survey, Washington, D. C.

Digitized by Google

and geologic features of the country and its mineral products. The topographic map shows roads, railroads, waterways, and, by contour lines, the shapes of the hills and valleys and the height above sea level of all points in the quadrangle. The areal-geology map shows the distribution of the various rocks at the surface. The structural-geology map shows the relations of the rocks to one another underground. The economic-geology map indicates the location of mineral deposits that are commercially valuable. The artesian-water map shows the depth to underground-water horizons. Economic-geology and artesian-water maps are included in folios if the conditions in the areas mapped warrant their publication. The folios are of special interest to students of geography and geology and are valuable as guides in the development and utilization of mineral resources.

The folios numbered from 1 to 163, inclusive, are published in only one form (18 by 22 inches), called the library edition. Some of the folios that bear numbers higher than 163 are published also in an octavo edition (6 by 9 inches). Owing to a fire in the Geological Survey building May 18, 1913, the stock of geologic folios was more or less damaged by fire and water, but the folios are usable and are sold at the uniform price of 5 cents each, with no reduction for wholesale orders. This rate applies to folios in stock from 1 to 184, inclusive (except reprints), also the library edition of folio 186. The library edition of folios 185, 187, and higher numbers sells for 25 cents a copy, except that some folios which contain an unusually large amount of matter sell at higher prices. The octavo edition of folio 185 and higher numbers sells for 50 cents a copy except folio 193, which sells for 75 cents a copy. If 34 folios selling at 25 cents each (or their equivalent in higher-priced folios) are ordered at one time a discount of 40 per cent is allowed; $5.10 is the minimum amount accepted at this rate.

All the folios contain descriptions of the drainage of the quadrangles. The folios in the following list contain also brief discussions of the underground waters in connection with the economic resources of the areas and more or less information concerning the utilization of the water resources.

An asterisk (*) indicates that the stock of the folio is exhausted.

*45. Boise, Idaho.

86. Ellensburg, Wash. 5c.

*103. Nampa, Idaho–Oregon.

Describes the relief, drainage, climate, and vegetation of the area; discusses the geologic history and geologic formations, and, under "Economic geology," the surface waters available for irrigation, the springs and shallow wells, and the artesian wells; indicates areas of possible artesian flow.

104. Silver City, Idaho. 5c.

106. Mount Stuart, Wash. 5c.

*139. Snoqualmie, Wash.

MISCELLANEOUS REPORTS.

Other Federal bureaus and State and other organizations have from time to time published reports relating to the water resources of various sections of the country. Notable among those pertaining to the northern Pacific coast drainage basins are the reports of the commissioner of conservation of the State of Montana; the State land commission; the State engineer of Idaho; the Bureau of Industry, Agriculture, and Irrigation of Nevada; the State engineers of Nevada, Oregon, Utah, and Washington; the annual reports of the United States Reclamation Service; and the reports of the Chief of Engineers, U. S. Army. The following reports deserve special mention:

Digitized by Google

The Oregon system of water titles, by John H. Lewis: Oregon State Engineer Bull. 2, 1912.

State and National water laws, with a detailed statement of the Oregon system of water titles, by John H. Lewis, with a discussion by Clarence T. Johnston and L. J. Le Conte: Am. Soc. Civil Eng. Trans., vol. 76, pp. 637–758, 1913.

Report of the commission on conservation [State of Montana] on bills relating to public lands, water rights, and the protection and preservation of the forests: Helena, 1911; also report of the governor of the State of Montana on the same subject.

How to appropriate the public waters of the State of Nevada, compiled by W. M. Kearney, State engineer, 1911.

Requirements and regulations, including suggestions and instructions in relation to the appropriation, use, and measurement of water in the State of Nevada: State engineer of Nevada, 1912.

Irrigation pumping in Nevada, etc., by Charles Norcross: Nevada Bur. of Industry, Agr., and Irr. Bull. 8, 1913.

The water resources of Washington: Potable and mineral water, by H. G. Byers; artesian water, by C. A. Ruddy; water power, by R. E. Heine: Washington Geol. Survey Ann. Rept. for 1901, vol. 1, pt. 5, 1902.

Preliminary report on the Quincy Valley irrigation project, by Henry Landes and others: Washington Geol. Survey Bull. 14, 1912.

Biennial Report of the State Commissioner of Arid Lands [Washington], 1895–96 and 1897–98.

The irrigated lands of the State of Washington, by George M. Allen, deputy commissioner: State Bureau of Statistics and Immigration, 1910.

Irrigation laws of the State of Wyoming, prepared for publication in the office of the State engineer, 1909.

Digitized by Google

GEOLOGICAL SURVEY HYDROLOGIC REPORTS OF GENERAL INTEREST.

The following list comprises reports not readily classifiable by drainage basins and covering a wide range of hydrologic investigations:

WATER-SUPPLY PAPERS.

*1. Pumping water for irrigation, by H. M. Wilson. 1896. 56 pp., 9 pls.

Describes pumps and motive powers, windmills, water wheels, and various kinds of engines; also storage reservoirs to retain pumped water until needed for irrigation.

*3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls. See Water-Supply Paper 22.) 10c.

Discusses methods of sewage disposal by intermittent filtration and by irrigation; describes utilization of sewage in Germany, England, and France, and sewage purification in the United States.

*8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls. 10c.

Gives results of experimental tests of windmills during the summer of 1896 in the vicinity of Garden, Kans; describes instruments and methods and draws conclusions.

*14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl.

Discusses efficiency of pumps and water lifts of various types.

*20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls. 15c.

Includes tables and descriptions of wind wheels, compares wheels of several types, and discusses results.

*22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls. 15c.

Gives résumé of Water-Supply Paper 3; discusses pollution of certain streams, experiments on purification of factory wastes in Massachusetts, value of commercial fertilizers, and describes American sewage-disposal plants by States; contains bibliography of publications relating to sewage utilization and disposal.

*41. The windmill, its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls. 5c.

*42. The windmill, its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp. (73–147), 2 pls. (15–16). 10c.

Nos. 41 and 42 give details of results of experimental tests with windmills of various types.

*43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901. 86 pp., 15 pls. 15c.

*56. Methods of stream measurement. 1901. 51 pp., 12 pls. 15c.

Describes the methods used by the Survey in 1901–2. See also Nos. 64, 94, and 95.

*64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls. (See No. 95.) 10c.

Describes methods of measuring velocity of water and of measuring and computing stream flow and compares results obtained with the different instruments and methods; describes also experiments and results at the Cornell University hydraulic laboratory. A second, enlarged, edition published as Water-Supply Paper 95.

*67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls. 15c.

Discusses origin, depth, and amount of ground waters; permeability of rocks and porosity of soils; causes, rates, and laws of motions of ground water; surface and deep zones of flow, and recovery of waters by open wells and artesian and deep wells; treats of the shape and position of the water table; gives simple methods of measuring yield of flowing well; describes artesian wells at Savannah, Ga.

Digitized by Google

72. Sewage pollution in the metropolitan area near New York City and its effect on inland water resources, by M. O. Leighton. 1902. 75 pp., 8 pls. 10c.

Defines "normal" and "polluted" waters and discusses the damage resulting from pollution.

*80. The relation of rainfall to run-off, by G. W. Rafter. 1903. 104 pp. 10c.

Treats of measurements of rainfall and laws and measurements of stream flow; gives rainfall, run-off, and evaporation formulas; discusses effects of forests on rainfall and run-off.

87. Irrigation in India (second edition), by H. M. Wilson. 1903. 238 pp., 27 pls. 25c.

First edition was published in Part II of the Twelfth Annual Report.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904. 361 pp. 25c. [Requests for this paper should be addressed to the U. S. Reclamation Service.]

Contains, in addition to an account of the organization of the hydrographic [water-resources] branch of the United States Geological Survey and the reports of the conference, the following papers of more or less general interest:

Limits of an irrigation project, by D. W. Ross.
Relation of Federal and State laws to irrigation, by Morris Bien.
Electrical transmission of power for pumping, by H. A. Storrs.
Correct design and stability of high masonry dams, by Geo. Y. Wisner.
Irrigation surveys and the use of the plane table, by J. B. Lippincott.
The use of akaline waters for irrigation, by Thomas H. Means.

*94. Hydrographic manual of the United States Geological Survey, prepared by E. C. Murphy, J. C. Hoyt, and G. B. Hollister. 1904. 76 pp., 3 pls. 10c.

Gives instruction for field and office work relating to measurements of stream flow by current meters. See also No. 95.

*95. Accuracy of stream measurements (second, enlarged edition), by E. C. Murphy. 1904. 169 pp., 6 pls.

Describes methods of measuring and computing stream flow and compares results derived from different instruments and methods. See also No. 94.

*103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. (See No. 152.)

Explains the legal principles under which antipollution statutes become operative, quotes court decisions to show authority for various deductions, and classifies according to scope the statutes enacted in the different States.

110. Contributions to the hydrology of eastern United States, 1904; M. L. Fuller, geologist in charge. 1905. 211 pp., 5 pls. 10c.

Contains the following reports of general interest. The scope of each paper is indicated by its title.

Description of underflow meter used in measuring the velocity and direction of underground water, by Charles S. Slichter.

The California or "stovepipe" method of well construction, by Charles S. Slichter.

Approximate methods of measuring the yield of flowing wells, by Charles S. Slichter.

Corrections necessary in accurate determinations of flow from vertical well casings, from notes furnished by A. N. Talbot.

Experiments relating to problems of well contamination at Quitman, Ga., by S. W. McCallie.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls. 5c.

The first paper discusses the pollution of streams by sewage and by trade wastes, describes the manufacture of strawboard, and gives results of various experiments in disposing of the waste. The second paper describes briefly the topography, drainage, and geology of the region about Marion, Ind., the contamination of rock wells and of streams by waste oil and brine.

*114. Underground waters of eastern United States; M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains report on "Occurrence of underground waters," by M. L. Fuller, discussing sources, amount, and temperature of waters, permeability and storage capacity of rocks, water-bearing formations, recovery of water by springs, wells, and pumps, essential conditions of artesian flows, and general conditions affecting ground waters in eastern United States.

Digitized by Google

119. Index to the hydrographic progress reports of the United States Geological Survey, 1888 to 1903, by J. C. Hoyt and B. D. Wood. 1905. 253 pp. 15c.

120. Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller. 1905. 128 pp. 10c.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

Defines and classifies underground waters, gives common-law rules relating to their use, and cites State legislative acts affecting them.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Discusses the capacity of sand to transmit water, describes measurements of underflow in Rio-Hondo, San Gabriel, and Mohave River valleys, Calif., and on Long Island, N. Y., gives results of tests of wells and pumping plants, and describes stovepipe method of well construction.

143. Experiments on steel-concrete pipes on a working scale, by J. H. Quinton. 1905. 61 pp., 4 pls. 5c.

Scope indicated by title.

145. Contributions to the hydrology of eastern United States, 1905; M. L. Fuller, geologist in charge. 1905. 220 pp., 6 pls. 10c.

Contains brief reports of general interest as follows:

Drainage of ponds into drilled wells, by Robert E. Horton. Discusses efficiency, cost, and capacity of drainage wells, and gives statistics of such wells in southern Michigan.

Construction of so-called fountain and geyser springs, by Myron L. Fuller.

A convenient gage for determining low artesian heads, by Myron L. Fuller.

146. Proceedings of second conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1905. 267 pp. 15c. [Inquiries concerning this report should be addressed to the U. S. Reclamation Service.]

Contains brief account of the organization of the hydrographic [water-resources] branch and the Reclamation Service, reports of conferences and committees, circulars of instruction, and many brief reports on subjects closely related to reclamation, and a bibliography of technical papers by members of the service. Of the papers read at the conference those listed below (scope indicated by title) are of more or less general interest:

Proposed State code of water laws, by Morris Bien.
Power engineering applied to irrigation problems, by O. H. Ensign.
Estimates on tunneling in irrigation projects, by A. L. Fellows.
Collection of stream-gaging data, by N. C. Grover.
Diamond-drill methods, by G. A. Hammond.
Mean-velocity and area curves, by F. W. Hanna.
Importance of general hydrographic data concerning basins of streams gaged, by R. E. Horton.
Effect of aquatic vegetation on stream flow, by R. E. Horton.
Sanitary regulations governing construction camps, by M. O. Leighton.
Necessity of draining irrigated land, by Thos. H. Means.
Alkali soils, by Thos. H. Means.
Cost of stream-gaging work, by E. C. Murphy.
Equipment of a cable-gaging station, by E. C. Murphy.
Silting of reservoirs, by W. M. Reed.
Farm-unit classification, by D. W. Ross.
Cost of power for pumping irrigating water, by H. A. Storrs.
Records of flow at current-meter gaging stations during the frozen season, by F. H. Tillinghast.

147. Destructive floods in the United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c.

Contains a brief account of "A method of computing cross-section area of waterways," including formulas for maximum discharge and area of cross section.

*150. Weir experiments, coefficients, and formulas, by R. E. Horton. 1906. 189 pp. 38 pls. (See Water-Supply Paper 200.) 15c.

Scope indicated by title.

Digitized by Google

151. Field assay of water, by M. O. Leighton. 1905. 77 pp., 4 pls.

Discusses methods, instruments, and reagents used in determining turbidity, color, iron, chlorides, and hardness in connection with the studies of the quality of water in various parts of the United States.

*152. A review of the laws forbidding pollution of inland waters in the United States (second edition), by E. B. Goodell. 1905. 149 pp. 10c.

Scope indicated by title.

*155. Fluctuations of the water level in wells, with special reference to Long Island, N. Y., by A. C. Veatch. 1906. 83 pp., 9 pls. 25c.

Includes general discussion of fluctuation changes due to rainfall and evaporation, barometric changes, temperature changes, changes in rivers, changes in lake level, tidal changes, effects of settlement, irrigation, dams, underground-water developments, and to indeterminate causes.

*160. Underground-water papers, 1906; M. L. Fuller, geologist in charge. 1906. 104 pp., 1 pl.

Gives account of work in 1905; lists publications relating to ground waters, and contains the following brief reports of general interest:

Significance of the term "artesian," by Myron L. Fuller.
Representation of wells and springs on maps, by Myron L. Fuller.
Total amount of free water in the earth's crust, by Myron L. Fuller.
Use of fluorescein in the study of underground waters, by R. B. Dole.
Problems of water contamination, by Isaiah Bowman.
Instances of improvement of water in well, by Myron L. Fuller.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

*163. Bibliographic review and index of underground-water literature published in the United States in 1905, by M. L. Fuller, F. G. Clapp, and B. L. Johnson. 1906. 130 pp. 15c.

Scope indicated by title.

*179. Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906. 34 pp., 1 pl. 10c.

Describes grain distillation; treatment of slop; sources, character, and effects of effluents on streams; discusses filtration, precipitation, fermentation, and evaporation methods of disposal of wastes without pollution.

*180. Turbine water-wheel tests and power tables, by R. E. Horton. 1906. 134 pp., 2 pls. 20c.

Scope indicated by title.

*185. Investigations on the purification of Boston sewage, by C.-E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.

Discusses composition, disposal, purification, and treatment of sewages and tendencies in sewage-disposal practice in England, Germany, and the United States; describes character of crude sewage at Boston, removal of suspended matter, treatment in septic tanks, and purification in intermittent sand filteration and coarse material; gives bibliography.

*186. Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906. 36 pp., 1 pl.

Gives history of pollution by acid-iron wastes at Shelby, Ohio, and the resulting litigation; discusses effect of acid-iron liquors on sewage-purification processes, recovery of copperas from acid-iron wastes, and other processes for removal of pickling liquor.

*187. Determination of stream flow during the frozen season, by H. K. Barrows and R. E. Horton. 1907. 93 pp., 1 pl. 15c

Scope indicated by title.

Digitized by Google

*189. The prevention of stream pollution by strawboard waste, by E. B. Phelps. 1906. 29 pp., 2 pls.

Describes manufacture of strawboard, present and proposed methods of disposal of waste liquors, laboratory investigations of precipitation and sedimentation, and field studies of amount and character of water used, raw material and finished product, and mechanical filtration.

*194. Pollution of Illinois and Mississippi rivers by Chicago sewage (a digest of the testimony taken in the case of the State of Missouri *v.* the State of Illinois and the Sanitary District of Chicago), by M. O. Leighton. 1907. 369 pp., 2 pls.

Scope indicated by amplification of title.

*200. Weir experiments, coefficients, and formulas (revision of paper No. 150), by R. E. Horton. 1907. 195 pp., 38 pls. 35c.

Scope indicated by title.

*226. The pollution of streams by sulphite-pulp waste, a study of possible remedies, by E. B. Phelps. 1909. 37 pp., 1 pl. 10c.

Describes manufacture of sulphite pulp, the waste liquors, and the experimental work leading to suggestions as to methods of preventing stream pollution.

*229. The disinfection of sewage and sewage filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 1909. 91 pp., 1 pl. 15c.

Scope indicated by title.

*234. Papers on the conservation of water resources. 1909. 96 pp., 2 pls. 15c.

Contains the following papers, whose scope is indicated by their titles: Distribution of rainfall, by Henry Gannett; Floods, by M. O. Leighton; Developed water powers, compiled under the direction of W. M. Steuart, with discussion by M. O. Leighton; Undeveloped water powers, by M. O. Leighton; Irrigation, by F. H. Newell; Underground waters, by W. C. Mendenhall; Denudation, by R. B. Dole and Herman Stabler; Control of catchment areas, by H. N. Parker.

*235. The purification of some textile and other factory wastes, by Herman Stabler and G. H. Pratt. 1909. 76 pp. 10c.

Discusses waste waters from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and manufacture of oleomargarine, fertilizer, and glue.

236. The quality of surface waters in the United States, Part I, Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collection of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results.

238. The public utility of water powers and their governmental regulation, by René Tavernier and M. O. Leighton. 1910. 161 pp. 15c.

Discusses hydraulic power and irrigation, French, Italian, and Swiss legislation relative to the development of water powers, and laws proposed in the French Parliament; reviews work of bureau of hydraulics and agricultural improvements of the French department of agriculture, and gives résumé of Federal and State water-power legislation in the United States.

*255. Underground waters for farm use, by M. L. Fuller. 1910. 58 pp., 17 pls. 15c.

Discusses rocks as sources of water supply and the relative safety of supplies from different materials; springs and their protection; open or dug and deep wells, their location, yield, relative cost, protection, and safety; advantages and disadvantages of cisterns and combination wells and cisterns.

*257. Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls. 15c.

Discusses amount, distribution, and disposal of rainfall; water-bearing rocks; amount of ground water; artesian conditions; oil and gas bearing formations; gives history of well drilling in Asia, Europe, and the United States; describes in detail the various methods and the machinery used; discusses loss of tools and geologic difficulties, contamination of well waters and methods of prevention, tests of capacity and measurement of depth, and costs of sinking wells.

Digitized by Google

*258. Underground-water papers, 1910, by M. L. Fuller, F. G. Clapp, G. C. Matson, Samuel Sanford, and H. C. Wolff. 1911. 123 pp., 2 pls. 15c.

Contains the following papers (scope indicated by titles) of general interest:
Drainage by wells, by M. L. Fuller.
Freezing of wells and related phenomena, by M. L. Fuller.
Pollution of underground waters in limestone, by G. C. Matson.
Protection of shallow wells in sandy deposits, by M. L. Fuller.
Magnetic wells, by M. L. Fuller.

*315. The purification of public water supplies, by G. A. Johnson. 1913. 84 pp., 8 pls. 10c.

Discusses ground, lake, and river waters as public supplies, development of water-works systems in the United States, water consumption, and typhoid fever; describes methods of filtration and sterilization of water and municipal water softening.

334. The Ohio Valley flood of March-April, 1913 (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson. 1913. 96 pp., 22 pls. 20c.

Although relating specifically to floods in the Ohio Valley, this report discusses also the causes of floods and the prevention of damage by floods.

*337. The effects of ice on stream flow, by William Glenn Hoyt. 1913. 77 pp., 7 pls. 15c.

Discusses methods of measuring the winter flow of streams.

*345. Contributions to the hydrology of the United States, 1914; N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

(*e*) A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce, pp. 53–65.

*364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of waters from rivers, lakes, wells, and springs in various parts of the United States, including analyses of the geyser water of Yellowstone National Park, hot springs in Montana, brines from Death Valley, water from the Gulf of Mexico, and mine waters from Tennessee, Michigan, Missouri and Oklahoma, Montana, Colorado and Utah, Nevada and Arizona, and California.

371. Equipment for current-meter gaging stations, by G. J. Lyon. 1915. 64 pp., 37 pls. 20c.

Describes methods of installing automatic and other gages and of constructing gage wells shelters, and structures for making discharge measurements and artificial controls.

*375. Contributions to the hydrology of the United States, 1915; N. C. Grover, chief hydraulic engineer. 1916. 181 pp., 9 pls. 15c. Contains:

(*c*) The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport, pp. 77–84.

(*e*) A method of correcting river discharge for a changing stage, by B. E. Jones, pp. 117–130.

(*f*) Conditions requiring the use of automatic gages in obtaining records of stream flow, by C. H. Pierce, pp. 131–139.

Three papers presented at the conference of engineers of the water-resources branch in December, 1914.

*400. Contributions to the hydrology of the United States, 1916; N. C. Grover, chief hydraulic engineer. 108 pp., 7 pls. Contains:

(*a*) The people's interest in water-power resources, by G. O. Smith, pp. 1–8.
(*c*) The measurement of silt-laden streams, by R. C. Pierce, pp. 39–51.
(*d*) Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt, pp. 53–59.

416. The divining rod, a history of water witching, with a bibliography, by Arthur J. Ellis. 1917. 59 pp. 10c.

A brief paper published "merely to furnish a reply to the numerous inquries that are continually being received from all parts of the country" as to the efficacy of the divining rod for locating underground water

Digitized by Google

*425. Contributions to the hydrology of the United States, 1917; N. C. Grover, chief hydraulic engineer. 1918. Contains:

*(c) Hydraulic conversion tables and convenient equivalents, pp. 71-94. 1917.

427. Bibliography and index of the publications of the United States Geological Survey relating to ground water, by O. E. Meinzer. 1918. 169 pp., 1 pl.

Includes publications prepared, in whole or in part, by the Geological Survey that treat any phase of the subject of ground water or any subject directly applicable to ground water. Illustrated by map showing reports that cover specific areas more or less thoroughly.

ANNUAL REPORTS.

*Fifth Annual Report of the United States Geological Survey, 1883–84, J. W. Powell, Director. 1885. xxxvi, 469 pp., 58 pls. $2.25. Contains:

*The requisite and qualifying conditions of artesian wells, by T. C. Chamberlin, pp. 125-173, pl. 21. Scope indicated by title.

*Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. *Pt. II, Irrigation, xviii, 576 pp., 93 pls. $2. Contains:

*Irrigation in India, by H. M. Wilson, pp. 363-561, pls. 107 to 146. See Water-Supply Paper 87

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*American irrigation engineering, by H. M. Wilson, pp. 101-349, pls. 11 to 146. Discusses the economical aspects of irrigation, alkaline drainage, silt, and sedimentation; gives brief history of legislation; describes perennial canals in Idaho, California, Wyoming, and Arizona; discusses water storage at reservoirs of the California and other projects, subsurface sources of supply, pumping, and subirrigation.

Fourteenth Annual Report of the United States Geological Survey, 1892–93, J. W. Powell, Director. 1893. (Pt. II, 1894.) 2 parts. *Pt. II, Accompanying papers, xx, 597 pp., 73 pls. $2.10. Contains:

*The potable waters of eastern United States, by W. J. McGee, pp. 1-47. Discusses cistern water, stream waters, and ground waters, including mineral springs and artesian wells.

*Natural mineral waters of the United States, by A. C. Peale, pp. 49-88, pls. 3 and 4. Discusses the origin and flow of mineral springs, the source of mineralization, thermal springs, the chemical composition and analysis of spring waters, geographic distribution, and the utilization of mineral waters; gives a list of American mineral-spring resorts; contains also some analyses.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 6 parts in 7 vols. and separate case for maps with Pt. V. *Pt. II, Papers chiefly of a theoretic nature, v, 958 pp., 172 pls. $2.65. Contains:

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59-294, pls. 6 to 16. Discusses the amount of waters stored in sandstone, in soil, and in other rocks, and the depth to which ground water penetrates; gravitational, thermal, and capillary movements of ground waters, and the configuration of the ground-water surface; gives the results of experimental investigations on the flow of air and water through a rigid, porous medium, and through sand, sandstones, and silts; discusses results obtained by other investigators, and summarizes results of observations; discusses also rate of flow of water through sand and rock, the growth of rivers, rate of filtration through soil, interference of wells, etc.

*Theoretical investigation of the motion of ground waters, by C. S. Slichter, pp. 295-384, pl. 17. Scope indicated by title.

PROFESSIONAL PAPERS.

*72. Denudation and erosion in the southern Appalachian region and the Monongahela basin, by L. C. Glenn. 1911. 137 pp., 21 pls. 35c.

Describes the topography, geology, drainage, forests, climate, and population, and transportation facilities of the region, the relation of agriculture, lumbering, mining, and power development to erosion and denudation, and the nature, effects, and remedies of erosion; gives details of conditions in Holston, Nolichucky, French Broad, Little Tennessee, and Hiwassee River basins, along Tennessee River proper, and in the basins of the Coosa-Alabama system, Chattahoochee, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

Digitized by Google

86. The transportation of débris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pp., 3 pls. 70c.

The results of an investigation which was carried on in a specially equipped laboratory at Berkeley, Calif., and was undertaken for the purpose of learning "the laws which control the movement of bed load and especially to determine how the quantity of load is related to the stream slope and discharge and to the degree of comminution of the débris."

105. Hydraulic-mining débris in the Sierra Nevada, by G. K. Gilbert. 154 pp., 34 pls. 1917. 50c.

Presents the results of an investigation undertaken by the United States Geological Survey in response to a memorial from the California Miners' Association asking that a particular study be made of portions of the Sacramento and San Joaquin valleys affected by detritus from torrential streams. The report deals largely with geologic and physiographic aspects of the subject, traces the physical effects, past and future, of the hydraulic mining of earlier decades, the similar effects which certain other industries induce through stimulation of the erosion of the soil, and the influence of the restriction of the area of inundation by the construction of levees. Suggests cooperation by several interests for the control of the streams now carrying heavy loads of débris.

BULLETINS.

*32. Lists and analyses of the mineral springs of the United States (a preliminary study), by A. C. Peale. 1886. 235 pp.

Defines mineral waters, lists the springs by States, and gives tables of analyses so far as available.

*319. Summary of the controlling factors of artesian flows, by Myron L. Fuller. 1908. 44 pp., 7 pls. 10c.

Describes underground reservoirs, the sources of ground waters, the confining agents, the primary and modifying factors of artesian circulation, the essential and modifying factors of artesian flow, and typical artesian systems.

*479. The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pp. 5c.

Discusses the expression of chemical analyses, the chemical character of water and the properties of natural waters; gives a classification of waters based on property values and reacting values, and discusses the character of the waters of certain rivers as interpreted directly from the results of analyses; discusses also the relation of water properties to geologic formations, silica in river water, and the character of the water of the Mississippi and the Great Lakes and St. Lawrence River as indicated by chemical analyses.

695. The data of geochemistry (fourth edition), by F. W. Clarke. 1920. 832 pp. 45c.

Earlier editions were published as Bulletins 330, 491, and 616. Contains a discussion of the statement and interpretation of water analyses and a chapter on "Mineral wells and springs" (pp. 175–211). Discusses the definition and classification of mineral waters, changes in the composition of water, deposits of calcareous, ocherous, and siliceous materials made by water, vadose and juvenile waters, and thermal springs in relation to volcanism. Describes the different kinds of ground water and gives typical analyses. Includes a brief bibliography of papers containing water analyses.

Digitized by Google

INDEX BY AREAS AND SUBJECTS.

[A=Annual Reports; M=Monograph; B=Bulletin; P=Professional Paper; W=Water-Supply Paper; G F=Geologic folio.]

Artesian waters: Essential conditions..... A 5; B 319; W 67, 114
Bibliographies [1]..... W 119, 120, 163, 427
Chemical analyses: [2] Methods and interpretation..... W 151, 236, 259, 274, 364; B 479
Conservation..... W 234, 400*a*
Conversion Tables..... W 425*c*
Débris reports..... P 86, 105
Denudation..... P 72
Divining rod..... W 416
Engineering methods..... P 86; W 1, 3, 8, 20, 41, 42, 43, 56, 64, 94, 95, 110, 143, 150, 180, 187, 200, 257, 337, 345*e*, 375*c*, 375*e*, 375*f*, 400*c*, 400*d*, 425*c*
Floods..... W 96, 147, 162, 334
Idaho: Profile surveys..... W 44, 346, 347, 420
Quality of waters..... W 274
Surface waters..... A 12 ii, 13 iii, 19 v; B 199; W 53, 54, 93, 162; G F 103
Underground waters..... B 199, 298; W 53, 54, 78; G F 45, 103, 104
India: Irrigation..... A 12 ii; W 87
Ice measurements..... W 187, 337
Irrigation, general..... A 10 ii, 11 ii, 12 ii, 13 iii, 16 ii, W 20, 22, 41, 42, 87
Legal aspects: Surface waters..... W 103, 152, 238
Underground waters..... W 122
Mineral springs: Analyses..... A 14 ii; B32
Origin, distribution, etc..... A 14 ii
Lists..... B 32; W 114
Montana: Profile surveys..... W 44, 346
Quality of waters..... 364
Surface waters..... A 19 v, 20 v
Underground waters..... B 298
Motions of ground waters..... A 19 ii, B 319; W 67, 110, 140
Nevada: Underground waters..... B 298
Oregon: Profile surveys..... W 44, 348, 349, 377, 378, 379
Quality of waters..... W 274, 363
Surface waters..... A 21 v; W 93, 96, 344, 363, 370
Underground waters..... B 252, 298; W 78; G F 103
Pollution: By industrial wastes..... W 179, 186, 189, 226, 235
By sewage..... W 72, 194
Laws forbidding..... W 103, 152
Indices of..... W 160
River profiles. *See* names of *States*.
Sanitation; quality of waters; pollution; sewage irrigation..... W 3, 22, 72, 103, 110, 113, 114, 145, 152, 160, 179, 185, 186, 189, 194, 226, 229, 235, 236, 255, 258, 315
Sewage disposal and purification..... W 3, 22, 72, 113, 185, 194, 229
Underground waters: Legal aspects..... W 122
Methods of utilization..... W 114, 255, 257
Pollution..... W 110, 145, 160, 258

[1] Many of the reports contain brief subject bibliographies. See abstracts.

[2] Many analyses of river, spring, and well waters are scattered through publications, as noted in abstracts.

Digitized by Google

Washington: Profile surveys..... W 44, 346, 366, 368, 369, 376, 377, 419
Quality of waters..... W 111, 339, 364
Surface waters. A 19 v, 21 v; W 55, 93, 111, 118, 253, 313, 339, 369; G F 139
Underground waters..... B 298; W 4, 55, 111, 118, 316, 425*e*; G F 139
Windmill papers..... W 1, 8, 20, 41, 42
Wyoming: Underground waters..... B 298

99664°—20—WSP 464——13

Digitized by Google

INDEX OF STREAMS.

	Page.
Agency Creek, Mont	x
Alkali Creek, Idaho	xvi
Allen ditch, Oreg	xx
American River, Wash	xii
Antelope Creek, Idaho	xv
Anthony Creek, Oreg	xviii
Applegate River, Oreg	xxv
Applegate River, Little, Oreg	xxv
Applegate River, Little, East Fork, Oreg	xxv
Applegate River, Little, West Fork, Oreg	xxv
Arnold canal, Oreg	xxi
Ashland Creek, Oreg	xxv
Ashley Creek, Mont	ix
Asotin Creek, Wash	xix
Ahtanum Creek, Wash	xii
Ahtanum Creek, North Fork, Wash.	xii
Ahtanum Creek, South Fork, Wash.	xii
Bailey Creek, Idaho	xiv
Baker Lake, Wash	viii
Baker River, Wash	viii
Baldock Slough, Oreg	xviii
Bear Creek, Idaho	xiv
Bear Creek (tributary to Rogue River), Oreg	xxv
Bear Creek (tributary to Wallowa River), Oreg	xix
Beitle ditch, Oreg	xx
Bennett Creek, Idaho	xvi
Big Bend ditch, Oreg	xix
Big Blackfoot River, Mont	ix
Big Butte Creek, Oreg	xxv
Big Cottonwood Creek, Idaho	xv
Big Creek (tributary to Flathead River), Mont	ix
Big Creek (tributary to Pahsimeroi River), Idaho	xix
Big Creek (tributary to Powder River), Oreg	xix
Big Creek (tributary to Yakima River), Wash	xii
Big Elk Creek, Idaho	xiv
Big Knife Creek, Mont	x
Big Lost River, Idaho	xv
Big Marsh Creek, Oreg	xxi
Big Muddy Creek, Wash	xxii
Big Muddy River, Wash	xxii
Big Wood River, Idaho	xvi
Big Wood Slough, Idaho	xvi
Birch Creek (tributary to Big Lost River), Idaho	xv
Birch Creek (tributary to Goose Creek), Idaho	xv
Birch Creek (tributary to Portneuf River), Idaho	xv
Bird's Nest ditch, Nev	xv
Bitterroot River, Little, Mont	ix
Bitterroot River, Mont	ix
Bitterroot River, East Fork, Mont.	ix
Bitterroot River, West Fork, Mont.	ix
Blackfoot-Marsh reservoir, Idaho	xiv
Blackfoot River, Idaho	xiv
Blackfoot River, Big, Mont	ix
Blackfoot River, Little, Idaho	xiv
Blackfoot River, Little, Mont	ix
Blodgett Creek, Mont	x
Boise River, Idaho	xvii
Boise River, South Fork, Idaho	xvii
Breitenbush Creek, Oreg	xxiv
Brownell ditch, Oreg	xx
Bruneau River, Idaho, Nev	xvi
Bruneau River, East Fork, Idaho	xvi
Buckaroo ditch, Idaho	xvi
Buffalo Fork, Wyo	xiii
Bull Run River, Oreg	xxiii
Bully Creek, Oreg	xvii, xviii
Bumping Lake, Wash	xii
Bumping River, Wash	xii
Burns Creek, Idaho	xiv
Burnt River, Oreg	xviii
Burnt River, Middle Fork, Oreg	xviii
Burnt River, North Fork, Oreg	xviii
Burnt River, South Fork, Oreg	xviii
Butte Creek, Big, Oreg	xxv
Butte Creek, Little, Oreg	xxv
Butte Creek, Little, North Fork, Oreg	xxv
Butte Creek, Little, South Fork, Oreg	xxv
Butte Creek, South Fork, Oreg	xxv
Cable Creek, Oreg	xx
Cabin Creek, Wyo	xiv
Cabin Creek, Wash	xi

Digitized by Google

Page.
Calapooya Creek, Oreg. xxv
Callahan Creek, Mont. ix
Camas Creek (tributary to Big Lost River), Idaho. xv
Camas Creek (tributary to Big Wood River), Idaho. xvi
Camas Creek, Little, Idaho. xvii
Camas Creek, Oreg. xx
Cameron ditch, Oreg. xxv
Camp Creek, Oreg. xviii
Canyon Creek, Oreg. xxii
Canyon Creek, Wash. viii
Canyon Creek, Little, Idaho. xvi
Carbon River, Wash. vii
Cascade canal, Wash. xii
Cascade River, Wash. viii
Cassia Creek, Idaho. xv
Castle Creek, Idaho. xvi
Catherine Creek. Oreg. xix
Cedar Creek (tributary to Big Lost River), Idaho. xv
Cedar Creek (tributary to Salmon Falls Creek), Idaho. xvi
Cedar River, Wash. viii
Central Oregon canal, Oreg. xxi
Charles Lisle ditch, Oreg. xx
Chehalis River, Wash. vii
Chelan Lake, Wash. xi
Chelan River, Wash. xi
Cherry Creek, Idaho. xvi
Chewack Creek, Wash. xi
Chiwaukum Creek, Wash. xi
Chiwawa Creek, Wash. xi
Cispus River, Wash. xxiv
Clackamas River, Oreg. xxiv
Clackamas River, Oak Grove Fork, Oreg. xxiv
Clark Fork, Idaho, Mont., Wash. . ix
Cle Elum Lake, Wash. xii
Cle Elum River, Wash. xii
Cle Elum River, North Fork, Wash xii
Clear Creek (tributary to Raft River), Idaho. xv
Clear Creek (tributary to Sauk River), Wash. viii
Clear Fork of Sandy River, Oreg. . xxiii
Clear Fork, Wash. xxiv
Clearwater River, Idaho. xix
Clearwater River, South Fork, Idaho. xix
Coal Creek, Wash. xxiv
Coast Fork of Willamette River, Oreg. xxiii

Page.
Coeur d'Alene Lake, Idaho. x
Coeur d'Alene River, Idaho. x
Coeur d'Alene River, Little North Fork, Idaho. x
Coeur d'Alene River, North Fork, Idaho. x
Cold Springs Creek, Idaho. xvi
Columbia River, Oreg., Wash. ix
Columbia Southern canal, Oreg. . . xxi
Company ditch, Oreg. xix
Congdon canal, Wash. xii
Coquille River, South Fork, Oreg. xxv
Cottonwood Creek, Wyo. xiii
Cottonwood Creek, Idaho. xvii
Cottonwood Creek, Big, Idaho. . . . xv
Cougar Creek, Wash. xxii
Cow Creek (tributary to Jordan Creek), Oreg. xvii
Cow Creek (tributary to Umpqua River), Oreg. xxv
Cow Creek (tributary to Willow Creek), Oreg. xviii
Cow Creek (tributary to Palouse River), Wash. xx
Cowlitz River, Wash. xxiv
Crab Creek, Wash. xi
Crane Creek, Idaho. xviii
Crescent Creek, Oreg. xxi
Crooked River, Oreg. xxi
Crow Creek, Mont. x
Cunningham Creek, Wash. xxii
Daly Creek, Oreg. xix
Dayville ditch, Oreg. xx
Dead Indian Creek, Oreg. xxv
Deadwood Creek, Idaho. xvi
Deschutes River, Oreg. xxi
Deschutes River, East Fork, Oreg. xxi
Devil Creek, Idaho. xvi
Dog Creek, Wyo. xiv
Dosewallips River, Wash. vii
Dry Creek (tributary to Big Wood River), Idaho. xvi
Dry Creek (tributary to Boise River), Idaho. xvii
Dry Creek (tributary to Snake River), Idaho. xv
Dry Creek (tributary to Mission Creek), Mont. x
Duckabush River, Wash. vii
Dungeness River, Wash. vii
Eagle Creek, Oreg. xix
Eagle Creek, West Fork, Oreg. xix

Digitized by Google

Page.
East Boar's Nest ditch, Nev..... XVI
East Finley Creek, Mont..... X
East Fork. *See name of main stream.*
East Fork Irrigation District canal, Oreg..... XXII
Eightmile Creek, Idaho..... XIX
Ellensburg Water Co.'s canal, Wash XII
Elliott ditch, Oreg..... XXI
Elk Creek, Big, Idaho..... XIV
Elk Creek, Little, Idaho..... XIV
Elwha River, Wash..... VII
Entiat River, Wash..... XI
Eugene power canal, Oreg..... XXIII
Evans Creek, Oreg..... XXV
Fall Creek, Idaho..... XIV
Fall Creek, Oreg..... XXIII
Fall Creek, Wyo..... XIV
Fall River, Idaho..... XIV
Fall River, Oreg..... XXI
Falls Creek, Mont..... X
Farmers and Citizens' ditch, Oreg . XIX
Farmers' mill ditch, Oreg..... XX
Finley Creek, Mont..... X
Finley Creek, East, Mont..... X
First Creek, Oreg..... XXII
Fish Creek, Wyo..... XIV
Flat Creek, Wyo..... XIV
Flathead Lake, Mont..... IX
Flathead River, Mont..... IX
Flathead River, Middle Fork, Mont..... IX
Flathead River, South Fork, Mont. IX
Fort Hall lower canal, Idaho..... XIV
Fort Hall upper canal, Idaho..... XIV
Foss River, Wash..... VIII
Foss River, East Fork, Wash..... VIII
Fowler canal, Wash..... XII
Gellerman & Frohman ditch, Oreg. XVII
George Dunn ditch, Oreg..... XXV
Glacier Creek, Wash..... XXIV
Gleed canal, Wash. *See* Naches Canal Co.'s canal..... XII
Goldburg Creek, Idaho..... XIX
Goodrich Creek, Oreg..... XVIII
Goose Creek, Idaho..... XV
Goose Creek, Oreg..... XIX
Grande Ronde River, Oreg., Wash. XIX
Grandview canal, Idaho..... XVI
Granger ditch, Oreg..... XIX
Grave Creek, Oreg..... XXV
Grays Lake outlet, Idaho..... XIV
Green River, Wash..... VII

Page.
Greenwater River, Wash..... VII
Grimes Creek, Idaho..... XVII
Gros Ventre River, Wyo..... XIII
Hagar Creek, Wash..... XXIV
Hagar Creek, North Fork, Wash... XXIV
Hall Creek, Wash..... X
Hangman Creek, Wash. *See* Latah Creek..... XI
Harrell ditch, Nev..... XV
Harris Creek, Idaho..... XVIII
Hay Creek, Oreg..... XXII
Henrietta mill ditch, Oreg..... XX
Henrys Fork, Idaho..... XIII
Hermiston ditch, Oreg. *See* Maxwell Land & Irrigation Co.'s ditch XX
High Line ditch, Nev..... XV
Hinckle ditch, Oreg. *See* Western Land & Irrigation Co.'s ditch... XX
Hoback River, Wyo..... XIV
Hood River, Oreg..... XXII
Hood River, East Fork, Oreg..... XXII
Hood River, West Fork, Oreg..... XXII
Hope Mill ditch, Oreg..... XVIII
Horse Creek, Wyo..... XIV
Hurricane Creek, Oreg..... XIX
Icicle Creek, Wash..... XI
Idaho canal, Idaho..... XIV
Indian Creek, Idaho..... XIV
Indian ditch, Mont..... X
Island ditch, Nev..... XV
Jack Creek, Nev..... XVII
Jack Creek, Oreg..... XXII
Jackson Lake, Wyo..... XIII
Jakes Creek, Nev..... XV
"J. H." ditch, Oreg..... XVII
Jocko River, Mont..... X
Jocko River, Middle Fork, Mont.. X
Jocko River, North Fork, Mont... X
Jocko River, South Fork, Mont... X
John Day River, Oreg..... XX
John Day River, South Fork, Oreg. XX
Johnson Creek (tributary to Cowlitz River), Wash..... XXIV
Johnson Creek (tributary to Okanogan River), Wash..... XI
Jordan Creek, Oreg..... XVII
Kachess Lake, Wash..... XI
Kachess River, Wash..... XII
Kalama River, Wash..... XXIV
Kalawa River, Wash..... VII
Keechelus Lake, Wash..... XI
Kennewick canal, Wash..... XIII
Kettle River, Wash..... X

Digitized by Google

Page.
King Hill Creek, Idaho..... XVI
Kiona canal, Wash..... XIII
Kittitas canal, West, Wash..... XII
Klickitat River, Wash..... XXII
Klickitat River, Little, Wash..... XXII
Klickitat River, West Fork, Wash. XXII
Knife Creek, Big, Mont..... X
Kootenai River, Idaho-Mont..... IX
Lake. *See significant names.*
Lake Creek (tributary to Salmon River), Idaho..... XIX
Lake Creek (tributary to Metolius River), Oreg..... XXII
Lake Creek (tributary to Cowlitz River), Wash..... XXIV
Lake Fork of Payette River, Idaho. XVIII
Lake McDonald outlet, Mont..... IX
Lake Milner, Idaho..... XIII
Lake Walcott, Idaho..... XIII
Latah Creek, Wash..... XI
Latah Creek, North Fork, Wash... XI
Latourell Creek, Oreg..... XXIII
Lee-Polly ditch, Oreg..... XVIII
Lemhi River, Idaho..... XIX
Lewis Creek, Oreg..... XXI
McKay Creek (tributary to Deschutes River), Oreg..... XXI
Lewis River, Wash..... XXIV
Lisle & Crane ditch, Oreg..... XX
Lisle ditch, Charles, Oreg..... XX
Little Applegate River, Oreg..... XXV
Little Applegate River, East Fork, Oreg..... XXV
Little Applegate River, West Fork, Oreg..... XXV
Little Bitterroot River, Mont..... IX
Little Blackfoot River and ditch, Mont..... IX
Little Blackfoot River, Idaho..... XIV
Little Butte Creek, Oreg..... XXV
Little Butte Creek, North Fork, Oreg..... XXV
Little Butte Creek, South Fork, Oreg..... XXV
Little Camas canal, Idaho..... XVII
Little Camas Creek, Idaho..... XVII
Little Canyon Creek, Idaho..... XVI
Little Creek, Oreg..... XIX
Little Elk Creek, Idaho..... XIV
Little Klickitat River, Wash..... XXII
Little Lost River, Idaho..... XV
Little North Fork of Cœur d'Alene River, Idaho..... X
Little Sandy flume, Oreg..... XXIII

Page.
Little Sandy River, Oreg..... XXIII
Little Spokane River, Wash..... XI
Little White Salmon River, Wash. XXIII
Little Wood River, Idaho..... XVI
Lochsa River, Idaho..... XIX
Lolo Creek (tributary to Clearwater River), Idaho..... XIX
Lolo Creek (tributary to Bitterroot River), Mont..... IX
Lost Creek, Idaho..... XVIII
Lost Creek, Oreg..... XXIII
Lostine River, Oreg..... XIX
Lost River, Big, Idaho..... XV
Lost River, Little, Idaho..... XV
Louse Creek, Idaho..... XVI
Lower Vineyard ditch, Nev..... XV
Lower Yakima canal, Wash..... XIII
Luckiamute River, Oreg..... XXIV
Luse canal, Oreg..... XXV
Malheur Farmers' canal, Oreg..... XVII
Malheur River, Oreg..... XVII
Malheur River, North Fork, Oreg. XVII
Malheur River, South Fork, Oreg. XVII
Manastash Creek, Wash..... XII
Mann Creek, Idaho..... XVIII
Marble Creek, Oreg..... XVIII
Marion Fork of Santiam River, Oreg..... XXIII
Marks Creek, Oreg..... XXI
Marsh Creek, Big, Oreg..... XXI
Marys Creek, Idaho, Nev..... XVI
Maxwell ditch, Oreg..... XX
Maxwell Land & Irrigation Co.'s ditch, Oreg..... XX
McAllister's ditch, Oreg. *See* Squaw Creek.
McCoy Creek, Idaho..... XIV
McDonald Lake outlet, Mont..... IX
McKay Creek (tributary to Umatilla River), Oreg..... XX
McKenzie River, Oreg..... XXIII
McLaughlin ditch, Oreg..... XVII
McMullen Creek, Idaho..... XV
Meadow Creek, Idaho..... XIV
Methow River, Wash..... XI
Metolius River, Oreg..... XXII
Middle Fork. *See name of main stream.*
Middle Santiam River, Oreg..... XXIV
Mill Creek (tributary to Ochoco Creek), Oreg..... XXI
Mill Creek (tributary to Warm Springs River), Oreg..... XXII

Digitized by Google

Page.
Mill Creek (tributary to Goodrich Creek), Oreg. ... xviii
Mill Creek (tributary to Grande Ronde), Oreg. ... xix
Mill Creek (tributary to Rogue River), Oreg. ... xxv
Mill Creek (tributary to Umpqua River), Oreg. ... xxv
Mill Creek, Wash. ... xx
Miller Creek, Idaho ... xviii
Miller Creek, Wash. ... viii
Miller Creek, West Fork, Wash. ... viii
Minam River, Oreg. ... xix
Milner Lake, Idaho ... xiii
Minidoka canals, North and South sides, Idaho ... xv
Mission Creek, Mont. ... x
Molalla River, Oreg. ... xxiv
Monroe Creek, Idaho ... xviii
Moore Creek, Idaho ... xvii
Moses Lake, Wash. ... xi
Mosquito Creek, Wyo. ... xiv
Moyie River, Idaho ... ix
Moxee Co.'s canal, Wash. ... xii
Mud Creek, Mont. ... x
Muddy Creek, Big, Wash. ... xxii
Muddy River, Wash. ... xxiv
Muddy River, Big, Wash. ... xxii
Naches Avenue Union canal, Wash. ... xii
Naches Canal Co.'s canal, Wash. ... xii
Naches-Cowiche canal, Wash. ... xii
Naches River, Wash. ... xii
Nason Creek, Wash. ... xi
Nehalem River, Oreg. ... xxv
Neil Creek, Oreg. ... xxv
Nespelem River, Wash. ... xi
Nevada ditch, Oreg. ... xviii
New Reservation canal, Wash. ... xiii
Nisqually River, Wash. ... vii
Nooksack River, Wash. ... viii
Nooksack River, Middle Fork, Wash. ... viii
Nooksack River, North Fork, Wash. ... viii
North canal, Oreg. ... xxi
North Fork. *See name of main stream.*
North Powder River, Oreg. ... xviii
North Santiam River, Oreg. ... xxiii
North Side ditch, Nev. ... xvi
North Side Minidoka canal, Idaho. ... xv
North Side Twin Falls canal, Idaho ... xv

Page.
North Umpqua River, Oreg. ... xv
North Yakima mill waste, Wash. ... xii
North Yakima power canal, Wash. ... xii
North Yakima power waste, Wash. ... xii
Oak Grove Fork, Clackamas River, Oreg. ... xxiv
Ochoco Creek, Oreg. ... xxi
Odell Creek, Oreg. ... xxi
Ohanapecosh River, Wash. ... xxiv
Okanogan River, Wash. ... xi
Old Reservation canal, Wash. ... xiii
Old Settlers Slough, Oreg. ... xviii
Old Union canal, Wash. ... xii
Oregon canal, Central Oreg. ... xxi
Oregon Land & Water Co.'s ditch, Oreg. ... xx
Owyhee canal, Oreg. ... xvii
Owyhee River, Oreg., Nev. ... xvi, xvii
Owyhee River, South Fork, Nev. ... xvii
Pacific Creek, Wyo. ... xiii
Pacific Light & Power Co.'s tailrace, Oreg. ... xxii
Pahsimeroi River, Idaho ... xix
Palisade Creek, Idaho ... xiv
Palouse River, Wash. ... xx
Pamelia Creek, Oreg. ... xxiii
Payette River, Idaho ... xviii
Payette River, Lake Fork, Idaho. ... xviii
Payette River, North Fork, Idaho. ... xviii
Pearl Creek, Wash. ... xxii
Pebble Creek, Idaho ... xv
Pend Oreille Lake, Idaho ... ix
Peshastin Creek, Wash. ... xi
Phoenix ditch, Oreg. ... xv
Pilchuck Creek, Wash. ... viii
Pilot Butte canal, Oreg. ... xxi
Pine Creek, Idaho ... xiv
Pine Creek, Oreg. ... xviii
Pine Creek, Wash. ... xix
Pioneer ditch, Oreg. ... xx
Pole Creek, Oreg. ... xviii
Portneuf River, Idaho ... xv
Post Creek, Mont. ... x
Powder River, Oreg. ... xviii
Powder River, North, Oreg. ... xviii
Priest River, Idaho ... x
Prineville tailrace, Oreg. ... xxi
Prospect Creek, Mont. ... x
Puyallup River, Wash. ... vii
Puzzle Creek, Oreg. ... xxiii
Puzzle Creek, North Fork, Oreg. ... xxiii
Puzzle Creek, South Fork, Oreg. ... xxiii
Quinault River, Wash. ... vii
Racetrack Creek, Mont. ... ix

Digitized by Google

Page.
Raft River, Idaho..... xv
Railroad Creek, Wash..... xi
Rainy Creek, Idaho..... xiv
Rattlesnake Creek, Idaho..... xvii
Rattlesnake Creek, Mont..... ix
Reservation canal, New, Wash..... xiii
Reservation canal, Old, Wash..... xiii
Reservation drain, Wash..... xiii
Revais Creek, Mont..... x
Robinson Creek, Idaho..... xiii
Rock Creek (tributary to Snake River), Idaho..... xv
Rock Creek (tributary to Clark Fork), Mont..... ix
Rock Creek (tributary to John Day River), Oreg..... xx
Rock Creek (tributary to Columbia River), Wash..... xx
Rock Creek (tributary to Palouse River), Wash..... xx
Rockyford Creek, Wash..... xi
Rogue River, Oreg..... xxiv, xxv
Rogue River Valley canal, Oreg.. xv
Row River, Oreg..... xxiii
Sage Creek, Idaho..... xviii
St. Joe River, Idaho..... x
St. Maries River, Idaho..... x
St. Regis River, Mont..... ix
Salmon Creek (tributary to Pine Creek), Oreg..... xviii
Salmon Creek (tributary to Willamette River), Oreg..... xxiii
Salmon Creek, Wash..... xi
Salmon Falls Creek, Idaho, Nev... xv
Salmon River, Little White, Wash. xxiii
Salmon River, North Fork, Idaho. xix
Salmon River (tributary to Snake River), Idaho..... xix
Salmon River (tributary to Sandy River), Oreg..... xxiii
Salmon River, White, Wash..... xxii
Salt River, Idaho..... xiv
Salt Creek, Oreg..... xxiii
Sand Hollow ditch, Oreg..... xvii
Sandy flume, Little, Oreg..... xxiii
Sandy River, Oreg..... xxiii
Sandy River, Clear Fork, Oreg ... xxiii
Sandy River, Little, Oreg..... xxiii
Sandy River canal, Oreg..... xxiii
San Jacinto ditch, Nev..... xv
Sanpoil River, Wash..... xi
Santiam River, Oreg..... xxiii
Santiam River, Marion Fork, Oreg. xxiii

Page.
Santiam River, Middle, Oreg..... xxiv
Santiam River, South, Oreg..... xxiv
Satus Creek, Wash..... xiii
Sauk River, Wash..... viii
Sawmill Creek, Oreg..... xviii
Schanno canal, Wash..... xii
Selah-Moxee canal, Wash..... xii
Selah Valley canal, Wash..... xii
Selway River, Idaho..... xix
Shafer Creek, Idaho..... xviii
Sharp ditch, Idaho..... xv
Sheep Creek, Idaho..... xvi
Shitike Creek, Oreg..... xxii
Shoshone Creek, Nev..... xv
Siletz River, Oreg..... xxv
Silver Lake ditch, Oreg..... xix
Simcoe Creek, Wash..... xiii
Similkameen River, Wash..... xi
Sinlahekin Creek, Wash..... xi
Skagit River, Wash..... viii
Skokomish River, North Fork, Wash..... vii
Skykomish River, Wash..... viii
Skykomish River, North Fork, Wash..... viii
Skykomish River, South Fork, Wash..... viii
Slate Creek, Oreg..... xv
Slusher & Gould ditch, Oreg..... xx
Smith Creek, Idaho..... xvii
Snake River, Idaho, Wash., Wyo . xiii
Snoqualmie River, Wash..... viii
Snoqualmie River, Middle Fork, Wash..... viii
Snoqualmie River, North Fork, Wash..... viii
Snoqualmie River, South Fork, Wash..... viii
Soleduck River, Wash..... vii
Sommercamp Creek, Idaho..... xviii
South Fork. *See name of main stream.*
South Santiam River, Oreg..... xxiv
South Side Minidoka canal, Idaho. xv
South Side Twin Falls canal, Idaho xv
South Umpqua River, Oreg..... xxv
Spicer ditch, Oreg..... xv
Spokane River, Idaho, Wash..... x
Spokane River, Little, Wash..... xi
Spokane Valley Land & Water Co.'s canal, Wash..... x
Spread Creek, Wyo..... xiii
Spring Creek, Idaho..... xvii

Digitized by Google

Page.
Spring Creek, Wyo. xiii
Squaw Creek and McAllister's ditch, Oreg. xxi
Squaw Creek, Wash. xx
Squaw Creek canal, Oreg. xxi
Stehekin River, Wash. xi
Stetattle Creek, Wash. viii
Still Creek, Oreg. xxiii
Stilaguamish River, South Fork, Wash. viii
Stillwater River, Mont. ix
Stranger Creek, Wash. x
Streeter ditch, Idaho. xv
Sucker Creek, Idaho. xvi
Sullivan Creek, Wash. x
Sullivan Lake, Wash. x
Sultan River, Wash. viii
Sunnyside canal, Wash. xiii
Surveyors Creek, Wash. xxii
Swalley canal, Oreg. xxi
Swamp Creek, Wash. xxii
Swan River, Mont. ix
Swauk Creek, Wash xii
Swift Creek, Wash. xxiv
Tableland ditch, Oreg. xxi
Taneum Creek, Wash. xii
Teanaway River, Wash. xii
Teton River, Idaho. xiv
Thompson Creek, Oreg. xxv
Thompson River, Mont. x
Thousand Springs Creek, Idaho... xv
Three Creek, Idaho. xvi
Tieton canal, Wash. xii
Tieton River, Wash. xii
Tieton River, North Fork, Wash .. xii
Timber Creek, Idaho. xix
Timber Creek, West Fork, Idaho.. xix
Tokul Creek, Wash viii
Topons Creek, Idaho. xv
Toppenish Creek, Wash. xiii
Toutlè River, Wash. xxiv
Trapper Creek, Idaho xv
Trout Creek, Nev. xvi
Trout Creek, Oreg. xxii
Trout Creek, Wash. xxii
Tucannon River, Wash. xx
Tumalo Creek, Oreg. xxi
Tumalo feed canal, Oreg. xxi
Twin Falls canal, North Side, Idaho. xv
Twin Falls canal, South Side, Idaho. xv
Twisp River, Wash. xi

Page.
Tygh Creek, Oreg. xxii
Umatilla River, Oreg. xx
Umatilla River, North Fork, Oreg. xx
Umpqua River, Oreg. xxv
Umpqua River, North, Oreg. xxv
Umpqua River, South, Oreg. xxv
Upper Vineyard ditch, Nev. xv
Valley Creek (tributary to Jocko River), Mont. x
Valley Creek (tributary to Salmon River), Idaho. xix
Vines ditch, Oreg. xvii
Wagner Creek, Oreg. xxv
Walla Walla River, Oreg., Wash.. xx
Walla Walla River, South Fork, Oreg. xx
Wallowa Lake, Oreg. xix
Wallowa River, Oreg. xix
Wapatox canal, Wash. xii
Warm River, Idaho. xiii
Warm Springs River, Oreg. xxii
Weiser River, Idaho. xviii
Weiser River, Middle Fork, Idaho. xviii
Weiser River, West Fork, Idaho.. xviii
Wenas Creek, Wash. xii
Wenatchee River, Wash. xi
Wenatchee Valley canal, Wash.... xi
West Boar's Nest ditch, Nev. xv
Western Land & Irrigation Co.'s ditch, Oreg. xx
West Fork. *See name of main stream.*
West Kittitas canal, Wash. xii
Whatcom Creek, Wash. viii
Whatcom Lake, Wash. viii
Whitechuck River, Wash. viii
Whitefish River, Mont. ix
White River (tributary to Deschutes River), Oreg. xxii
White River (tributary to Puget Sound), Wash. ..... vii, viii
White River (tributary to Wenatchee River), Wash. xi
White River flume, Wash. viii
White Salmon River, Wash. xxii
White Salmon River, Little, Wash. xxiii
Whitewater Creek (tributary to Santiam River), Oreg. xxiv
Whitewater River (tributary to Metolius River), Oreg. xxii
Willamette River, Oreg. xxiii
Willamette River, Coast Fork, Oreg. xxiii

Digitized by Google

Page.
Willamette River, Middle Fork, Oreg. XXIII
Willamette River, North Fork of Middle Fork, Oreg. XXIII
Willow Creek (tributary to Snake River), Idaho. XIV
Willow Creek (tributary to South Fork of Boise River), Idaho. . . . XVII
Willow Creek (tributary to Salmon Falls Creek), Nev. XV
Willow Creek (tributary to Columbia River), Oreg. XX
Willow Creek (tributary to Malheur River), Oreg. XVIII
Willow Creek (tributary to Powder River), Oreg. XVIII
Wilson Creek, Wash. XII
Wilson ditch, Oreg. XVII
Wilson & Co.'s ditch, Oreg. XX
Wilson River, Oreg. XXV
Wilson River, North Fork, Oreg. . . XXV
Wimer canal, Oreg. XXI
Wolf Creek, Idaho. XIV
Wolf Creek, Oreg. XIX
Wood River, Big, Idaho. XVI
Wood River, Little, Idaho. XVI
Yaak River, Mont. IX
Yakima River, Wash. XI
Yakima Valley canal, Wash. *See* Congdon canal. XII
Yamhill River, Oreg. XXIV
Yamhill River, South Fork, Oreg. XXIV
Youngs River, Wash. XXIV

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
20 CENTS PER COPY
△

Digitized by Google

Digitized by Google

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

WATER-SUPPLY PAPER 465

SURFACE WATER SUPPLY OF HAWAII

JULY 1, 1916, TO JUNE 30, 1917

NATHAN C. GROVER, Chief Hydraulic Engineer
G. K. LARRISON, District Engineer

Prepared in cooperation with the
TERRITORY OF HAWAII

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

Digitized by Google

Digitized by Google

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 465

SURFACE WATER SUPPLY OF HAWAII

JULY 1, 1916, TO JUNE 30, 1917

NATHAN C. GROVER, Chief Hydraulic Engineer
G. K. LARRISON, District Engineer

Prepared in cooperation with the
TERRITORY OF HAWAII

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

Digitized by Google

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
15 CENTS PER COPY

Digitized by Google

CONTENTS.

	Page.
Authority for investigations	7
Cooperation	9
Scope of work	10
Field methods of measuring stream flow	10
Base data	10
Weir measurements	11
Velocity-area method	11
Definition of terms	15
Convenient equivalents	17
Office methods of computing and studying discharge and run-off	18
Explanation of tables	21
Accuracy of field data and computed results	22
Division of work	22
Gaging stations maintained in Hawaii	22
Gaging-station records	28
Island of Kauai	28
Waimea River near Waimea	28
Kawaikoi Stream near Waimea	30
Waiahulu Stream near Waimea	31
Koaie Stream near Waimea	32
Waialae River at elevation 800 feet, near Waimea	34
Kekaha ditch at flume No. 4, near Waimea	36
Kekaha ditch below tunnel No. 12, near Waimea	37
Waimea ditch near Waimea	39
Kamenehune ditch near Waimea	40
Makaweli River near Waimea	42
Olokele ditch at tunnel No. 12, near Makaweli	43
Olokele ditch at weir, near Makaweli	45
Hanapepe River at Koula, near Eleele	46
Hanapepe ditch at Koula, near Eleele	48
Hanapepe ditch at weir, near Hanapepe	49
South Fork of Wailua River near Lihue	50
Hanamaulu ditch near Lihue	52
Lihue ditch near Lihue	53
North Fork of Wailua River at elevation 650 feet, near Lihue	55
Kanaha ditch near Lihue	56
East Branch of North Fork of Wailua River near Lihue	58
Kapaa River near Kealia	59
Kapahi ditch near Kealia	61
Anahola River near Kealia	63
Anahola ditch above Kaneha reservoir, near Kealia	64
Kalihiwai River near Hanalei	66
Hanalei River at elevation 625 feet, near Hanalei	67
Hanalei River near Hanalei	69
China ditch near Hanalei	70

Digitized by Google

Gaging-station records—Continued.
Island of Kauai—Continued. Page.
Kuna ditch near Hanalei 72
Lumahai River near Hanalei 73
Waioli Stream near Hanalei 75
Wainiha River, east and west channels, near Wainiha 76
Miscellaneous measurements 79
Island of Oahu 79
Kalihi Stream near Honolulu 79
Nuuanu Stream below reservoir No. 2 wasteway, near Honolulu 81
Manoa Stream at College of Hawaii, near Honolulu 83
West Branch of Manoa Stream near Honolulu 85
East Branch of Manoa Stream near Honolulu 87
Makawao Spring near Kailua 89
Main spring near Kailua 89
Haiku Stream near Heeia 90
Kahana Stream near Kahana 91
East Branch of Kahana Stream near Kahana 93
Punaluu Stream at elevation 539 feet, near Punaluu 94
Punaluu Stream at elevation 250 feet, near Punaluu 96
Waihoi Stream near Punaluu 97
Kaluanui Stream near Hauula 98
Koloa Stream near Laie 100
Wailele Stream near Laie 101
East Branch of Kahawainui Stream near Laie 103
East Branch of Malaekahana Stream near Kahuku 105
Middle Branch of Malaekahana Stream near Kahuku 106
Right Branch of North Fork of Kaukonahua Stream near Wahiawa 108
Left Branch of North Fork of Kaukonahua Stream near Wahiawa 109
South Fork of Kaukonahua Stream above United States Army reservoir, near Wahiawa 111
South Fork of Kaukonahua Stream below United States Army reservoir, near Wahiawa 113
Miscellaneous measurements 115
Island of Maui 115
South Waiehu Stream near Wailuku 115
North Waiehu ditch near Wailuku 116
Waihee Stream near Waihee 118
Honokahau Stream near Honokahau 120
Honolua Stream near Honokahau 122
Honokawai Stream near Lahaina 123
Honokawai ditch near Lahaina 125
Kahoma Stream near Lahaina 126
Kahoma development tunnel near Lahaina 128
Lahainaluna Stream above pipe-line intake, near Lahaina 129
Kauaula Stream near Lahaina 131
Kauaula ditch near Lahaina 132
Launiupoko Stream near Lahaina 134
Olowalu ditch near Olowalu 135
Ukumehame Stream near Olowalu 137
Waikapu Stream near Waikapu 139
Palolo ditch near Waikapu 140
South Side Waikapu ditch near Waikapu 142
West Kopiliula Stream near Keanae 143

Digitized by Google

Gaging-station records—Continued.
Island of Maui—Continued. Page.
East Wailuaiki Stream near Keanae 145
West Wailuaiki Stream near Keanae 147
East Wailuanui Stream near Keanae 148
West Wailuanui Stream near Keanae 150
Honomanu Stream near Keanae 151
Haipuaena Stream near Huelo 153
Puohakamoa Stream near Huelo 155
Alo Stream near Huelo 156
Waikamoi Stream near Huelo 158
Nailiilihaele Stream near Huelo 159
Kailua Stream near Huelo 161
Hoolawaliilii Stream near Huelo 162
Hoolawanui Stream near Huelo 164
Honopou Stream near Huelo 165
New Hamakua ditch at Halehaku weir, near Huelo 167
Kauhikoa ditch at Opana weir, near Huelo 168
Lowrie ditch at Opana weir, near Huelo 169
Haiku ditch at Peahi weir, near Huelo 170
Miscellaneous measurements 171
Island of Hawaii 171
Upper Hamakua ditch at Puualala and reservoir No. 3 weirs, near Kukuihaele 171
Lower Hamakua ditch at main weir, near Kukuihaele 172
Kohala ditch at Awini weir, near Kohala 173
Kohala ditch at Niulii weir, near Kohala 176
Rainfall 180
General conditions 180
Rainfall stations 181
Kauai 181
Oahu 182
Maui 183
Hawaii 183
Records of rainfall 185
Index 189

Digitized by Google

Digitized by Google

SURFACE WATER SUPPLY OF HAWAII, JULY 1, 1916, TO JUNE 30, 1917.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of measurements of the flow of certain streams and ditches and records of rainfall in the Territory of Hawaii made during the year ending June 30, 1917. The investigations leading to the report were made by the United States Geological Survey in cooperation with the Territory of Hawaii, under the general sanction of the organic law of the Survey (Stat. L., vol. 20, p. 394), which contains the following paragraph:

> *Provided*, That this officer [the Director] shall have the direction of the geological survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

As water is the most abundant and most valuable of the minerals, the investigation of water resources is authorized under the provision for examining mineral resources. The work has been supported since the fiscal year ending June 30, 1895, by appropriations in successive sundry civil bills passed by Congress under the following item:

> For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

The legislature of the Territory of Hawaii approved on March 22, 1909, "An act to promote the conservation and development of the natural resources of the Territory," which provided in substance as follows: A special tax of 2 per cent shall be levied, assessed, and collected annually on all incomes in excess of $4,000; and all amounts so collected shall constitute a special fund to be expended only for the encouragement of immigration and the conservation of natural resources in the proportion of three-fourths for immigration and one-fourth for conservation. The conservation fund shall be used for the development, conservation, improvement, and utilization of the natural resources, and shall be available for expenditure at such times and in such manner as a board of three persons appointed in accordance with section 80 of the organic act shall, with the approval of the governor, determine.

An act of April 26, 1911, amended the original act so as to extend it until December 31, 1913.

On April 4, 1913, the governor of the Territory of Hawaii approved the following acts providing (act 56) for the creation and maintenance

Digitized by Google

of a division of hydrography under the board of agriculture and forestry, and (act 57) appropriating the revenues from water licenses for the use of the board of commissioners of agriculture and forestry toward forest protection and hydrographic surveying.

Section 1 of act 56 reads:

The board of agriculture and forestry is hereby authorized to create and maintain a division of hydrography for the investigation and determination of the water resources of the Territory by the gaging of streams and rainfall and other means, in cooperation with the United States Geological Survey or otherwise, and in furtherance thereof to take over and exercise the functions of the Territory in the conduct of the present hydrographic survey of the Territory.

Section 2 provides that this act shall take effect July 1, 1913.

Section 1 of act 57 reads:

All revenues derived from water licenses issued by the Territory during the period beginning July 1, 1913, and ending June 30, 1915, whether by way of rentals or otherwise, shall constitute and be held as a special fund in the treasury of the Territory to be disbursed on warrants of the auditor issued on approved vouchers of the president of the board of commissioners of agriculture and forestry. Such moneys shall be apportioned and applied from time to time by the board of commissioners of agriculture and forestry, acting with the approval of the governor, equally between the division of forestry and the division of hydrography to the following general purposes, and not otherwise:

1. For the protection of forest reservations, established or set apart according to law, against damage by fire, animals, and otherwise by means of fences and any other means whatsoever, and for the expenditures of the division of forestry.

2. For the development and maintenance of the hydrographic survey throughout the Territory.

Each voucher against said fund shall designate the general purpose for which it is drawn.

Section 2 provides that this act also shall take effect July 1, 1913.

Since June 30, 1915, the funds for the use of the division of hydrography have been supplied by successive appropriations from the general revenues of the Territory.

On March 23, 1917, the following act by the legislature of the Territory of Hawaii was approved:

ACT 27.

SECTION 1. The division of hydrography, authorized by and created pursuant to section 483 of the Revised Laws of Hawaii, 1915, is hereby transferred, together with all the materials, equipment, and supplies now under the control of the division or of the board of commissioners of agriculture and forestry for the division, to the commissioner of public lands.

SEC. 2. The commissioner of public lands shall have and exercise the same powers, duties, and jurisdiction with respect to said division as are now exercised by the board of commissioners of agriculture and forestry.

SEC. 3. All unexpended balances of appropriations heretofore made for said division, the expenditure of which is now by law vested in the board of commissioners of agriculture and forestry, are hereby transferred to the commissioner of public lands and the expenditure thereof vested in said commissioner.

SEC. 4. This act shall take effect upon its approval.

Digitized by Google

COOPERATION.

COOPERATION WITH THE TERRITORY OF HAWAII.

Under the authority conferred by the Federal and Territorial legislation, the Director of the United States Geological Survey and the governor of the Territory of Hawaii entered into a cooperative agreement, dating from July 1, 1910, for "the gaging of streams and the determination of the water supply of the Territory of Hawaii." [1]

The principal features of this agreement are:

1. The United States Geological Survey assumes the responsibility of gathering, analyzing, and publishing the data.

2. During the progress of the work all notes, maps, and data gathered as a result of field studies are at all times open to inspection by the representative of the Territory, and if they are not satisfactory the agreement can be terminated.

3. Accounts for payment of salaries, travel, and subsistence, supplies, or other expenses necessary to the completion of the work shall be rendered in the manner required by the laws and regulations of the contracting parties, and vouchers shall be presented to either party for payment according as it may be convenient or according to the balance remaining in the respective allotments.

4. The cost of publication is borne entirely by the Geological Survey.

Unless otherwise stated, all data have been collected and are published under this cooperative agreement with the Territory of Hawaii, which has borne from 60 to 80 per cent of the cost thereof.

Until June 30, 1913, the Territory of Hawaii was represented in the cooperation by the Board of Conservation; from July 1, 1913, to March 23, 1917, by the Board of Commissioners of Agriculture and Forestry; and since this date by the Commissioner of Public Lands.

OTHER COOPERATION.

Special investigations have been made in cooperation with the Hawaiian department of the United States Army, the city and county of Honolulu, and private persons and corporations, under one of the plans indicated in the following paragraphs:

1. Expense of work, equipment, or installation paid entirely or in part by the cooperating party or by direct reimbursement to the field men.

2. Records collected by employees of a cooperating party but under supervision of and by methods of the Survey.

3. Assistance given in the collection of records, such as furnishing transportation, subsistence, or equipment.

[1] The United States Geological Survey also cooperated with the Territory of Hawaii in mapping several islands. The whole of the islands of Kauai and Oahu and a part of the island of Hawaii have been mapped.

Digitized by Google

4. Records furnished by a cooperating party, collected by his methods and under his supervision.

Cooperation in the collection of records for whose accuracy responsibility has not rested with the Survey has been acknowledged in the descriptions of the stations. Special acknowledgment is due to the following individuals and companies cooperating under plans 1, 2, and 3: Island of Kauai—Hawaiian Sugar Co., Mr. Charles Rice, Makee Sugar Co., Kauai Electric Co., Waimea Sugar Co., and Lihue Plantation Co.; Island of Oahu—United States Army Constructing Quartermaster Department, Wahiawa Water Co., Kahuku Plantation, Laie Plantation, Koolau Agricultural Co., Kaneohe Ranch Co., and Maunawili Ranch; Island of Maui—Wailuku Sugar Co., Pioneer Mill Co., Olowalu Sugar Co., Honolua Ranch, and East Maui Irrigation Co.

SCOPE OF WORK.

The investigations of stream and ditch flow in the Territory are not complete nor do they include all the streams and ditches that might advantageously be studied. They include, however, as many of the streams and ditches on the four larger islands as the available appropriations would allow. It is essential that records of stream flow should be kept during a period of years long enough to determine within reasonable limits the range of flow from the maximum to the minimum. The length of such a period manifestly varies for different streams. Experience has shown that the records should be kept from 20 to 30 years.

In the performance of this work an effort is made to reach the highest degree of precision possible with a rational expenditure of time and money. In all engineering work there is a point beyond which refinement is needless and wasteful, and this statement applies with especial force to stream-measurement work in Hawaii. It has been found, however, that it is possible to obtain data which are sufficiently accurate, although many of those presented in this report are for periods too short to warrant definite conclusions.

Special intensive investigations of the discharge of many streams which are of major importance for domestic water supply, power, and irrigation have been made.

Investigations of ditch seepage and other losses, in many localities, were made in cooperation with the United States Army and private corporations.

FIELD METHODS OF MEASURING STREAM FLOW.

BASE DATA.

In making plans for power, irrigation, municipal water supply, and other projects involving the use of water from surface streams it is necessary to have data from which both the total flow of the stream and its distribution from day to day throughout the year can be

Digitized by Google

obtained. The data necessary for obtaining such information are daily gage heights, which give the fluctuations of rise and fall of the stream, and measurements of discharge at various stages, from which a rating curve and table can be prepared giving the discharge for any stage. Such a rating is possible from the fact that so long as the conditions at the controlling section in the stream remain the same the discharge will be approximately the same for any given gage height.

Points at which discharge measurements are made and records of daily fluctuations of stage are kept for determining the daily flow are termed gaging stations.

Gaging stations may be divided into two classes, known as weir stations and velocity-area stations. At weir stations the head of water on the crest of the weir is measured and the discharge computed by means of a formula. The discharge at velocity-area stations is obtained by measuring the velocity of the current and the area of cross section, the product of the two giving the discharge.

The data presented in this paper were collected at both weir and velocity-area stations.

WEIR MEASUREMENTS.

Unquestionably a weir properly constructed and of a type for which accurate coefficients have been determined is one of the most convenient and reliable means of measuring small quantities of water. In practice, however, weirs rarely conform to the requirements imposed by the experimenter who derived the coefficients. If the crest of the weir is sharp and clean and sufficiently high above the bottom of the leading channel, if the end contractions are complete and the velocity of approach is wanting or negligibly small, and if the head on the crest is measured at a distance back of the overfall at least as great as the length of the weir crest, the Francis formula will give good results. On the other hand, if these essential conditions are not complied with—if the weir is improperly constructed and there is leakage around and under it, and especially if the velocity of approach is considerable and the contractions are imperfect, the Francis formula will not give accurate results.

Observations made on various types of weirs in Hawaii show that not all the weirs in use in the Territory are giving accurate results. If the error is known, so that corrections can be made, the trouble is largely mitigated, but faulty weir records are too often accepted without investigation as to their accuracy.

VELOCITY-AREA METHOD.

The velocity-area method of measurement consists in determining the mean or average velocity of the water passing a given cross-section area. The area of the cross section at right angles to the direction of flow is ascertained by soundings which are taken at such distances

Digitized by Google

apart as will show the contour of the stream bed. The depths are recorded and also their distances from some arbitrarily chosen initial point on one side of the stream.

The method of making the soundings depends on the size and stage of the stream. On ditches and small streams, where the depths and velocities are not large, a graduated rod may be used; on large streams, which must be measured from bridges or cables, a lead weight and sounding line must be used. The size of weights—whether 10 or 15 pounds—depends on the swiftness of the current; and the weights are torpedo shaped, so as to offer as little resistance as possible to the moving water.

On streams whose beds are permanent or nearly so a standard cross section is usually constructed from careful soundings and referred to the zero of the gage, so that the depths for any stage can be found by adding the gage height at that stage to the depths below the zero of the gage. This method is especially useful at high stages, when it is difficult to make accurate soundings.

After the cross-section area of the stream has been measured by soundings and horizontal distances, the velocity is determined at a number of points. These measurements of velocity should be made at frequent intervals across the stream and close enough to take account of any abrupt change in the velocity. For convenience, the velocities are usually observed in the same verticals at which soundings are made. On some streams fairly good measurements of velocities may be made by means of subsurface floats. This method is applicable, however, only to channels of uniform cross-section area over a considerable distance, and is very unsatisfactory for use on natural streams like those of Hawaii.[1]

The velocity of flow is best determined by the current meter, which is a form of water wheel actuated by the current and of such size and shape that it can easily be placed at any point in the stream.

The penta-recording current meter consists of six cups attached to a vertical shaft which revolves on a conical hardened-steel point when immersed in moving water. The revolutions are indicated electrically or acoustically. The rating, or relation between the velocity of moving water and the revolutions of the wheel, is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity in feet per second of moving water for any number of revolutions in a given time. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds and is approximately 0.45.

[1] Further information regarding the float method is given in Water-Supply Paper 95 and in textbooks on stream flow.

Digitized by Google

Three classes of methods of measuring velocity with current meters are in general use—multiple-point, single-point, and integration.

The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

In the vertical velocity-curve method a series of velocity determinations are made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best known, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of velocities at 0.22 and 0.79 depth will give closely the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives very closely the mean velocity of water flowing in open channels and that in a completed measurement it seldom varies as much as 1 per cent from the result obtained by the vertical velocity-curve method. It is very extensively used by the United States Geological Survey.

In the single-point method the meter is held either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined or must be assumed.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual measurements is, however, greater than in the 0.2 and 0.8 method and the general results are not so satisfactory.

Digitized by Google

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind of other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements, or for measurements when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical integration method consists in moving the meter at a slow but uniform speed from the surface to the bottom and back again to the surface and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity determination.

In practical work on rough streams, such as many of those in Hawaii, the meter should be held at 0.6 depth if the depth is 1 foot or less. If the depth is greater the meter should be held at two points in the vertical, 0.2 and 0.8 from the surface.

When the mean velocities in the different verticals have been found, the average of two adjacent means is taken as the mean velocity for that individual section. The area of the section is computed by mulitplying the width of the section by the mean depth. The discharge of each section is then the product of the area multiplied by the mean velocity, and the total discharge of the stream results from summing up the discharge of the individual sections. In practice the work is tabulated in such a way as to render the computation very simple.[1]

Current-meter measurements are not practicable where there are eddies, cross currents, swirls, or passages for the water underneath stones. It is usually possible, however, to improve the channel by removing boulders and rocks, so that a satisfactory measuring section may be obtained, even on rough, steep streams such as exist in Hawaii.

Three kinds of velocity-area gaging stations are in general use in Hawaii, according to the means provided for making the observations of depth and velocity. They are wading, bridge, and cable stations.

A wading station is one at which measurements are made only by wading—that is, no means exist for getting above the water at any stage except by wading. Such stations are usually on ditches or wide, shallow streams, which do not fluctuate greatly. On many streams

[1]For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.

Digitized by Google

however, measurements are made at low stages by wading, even though other means exist for making measurements at higher stages.

A bridge station is one at which the meter is used from a bridge. In some places highway or other bridges are available from which to make measurements, but generally they are not at the right place on the stream. Special bridges are then built.

A cable station is one at which measurements are made from a cable spanning the stream. Cable stations are used on large streams, such as Hanapepe, Wailua, and Hanalei rivers on the island of Kauai, and Wailuku River on the island of Hawaii. The cable supports the car from which a man works above the water. Distances are marked off on the cable itself or on a small auxiliary cable stretched taut above it.

A suitable place for a gaging station having been selected, a staff gage is set in the edge of the stream, either vertical or inclined, but graduated into tenths, half-tenths, or hundredths of feet vertically. The gage is securely fastened to rocks or trees to prevent displacement by floods and is so placed that the zero, or reference datum, is well below extreme low water. The datum is also referred to a permanent bench mark as an additional precaution. A water-stage recorder is then installed or an observer is engaged to record the heights of water morning and evening, and the mean of the two readings is used as the mean gage height for the day. Owing to the rapid rise and fall of most of the streams in Hawaii, two gage-height readings a day will not as a rule give a true mean for the 24 hours. For this reason, and also owing to the fact that many of the gaging stations are necessarily situated in the mountains at points remote from all habitations and difficult of access, it has generally been found necessary to use water-stage recorders. These instruments are of various types, some requiring weekly visits and others operating for a month without attention.

The essential features of water-stage recorders comprise a float free to rise and fall with fluctuations of the water surface, a device for transferring the motion of the float to the record sheet (either directly or through a reducing mechanism), the recording device, and the clock. The instruments may be designed for any range of stage.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated more or less definitely with a certain class of work. These terms may be divided into two groups: (1) Those which represent a rate of flow, as "second-feet," "gallons per minute," "gallons per day," "miner's inches," and "run-off in second-feet per square mile," and (2) those which represent the actual quantity of water, as "run-

Digitized by Google

off in depth in inches," "million gallons," and "acre-feet." They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the unit for the rate of discharge of water flowing in a stream 1 square foot in cross section at a rate of 1 foot per second. It is generally adopted as the fundamental unit in the measurement of flowing water and is the "natural" unit, as the foot and the second are the units used in making the physical determinations. Other units may be computed from this by the use of factors given in the table of equivalents.

"Gallons per minute" is generally used in connection with pumping and city water supply, the United States gallon of 231 cubic inches being the unit of quantity and 1 minute the unit of time.

The "miner's inch" is the unit for the rate of discharge of water that passes through an orifice 1 inch square under a head which varies locally. It is commonly used by miners and irrigators throughout the West, and is defined by statute in each State in which it is used.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly, both as regards time and area.

"Run-off in inches" is the depth to which the drainage area would be covered if all the water flowing from it is a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

An "acre-foot" is equivalent to 43,560 cubic feet, and is the quantity required to cover an acre to the depth of 1 foot. The term is commonly used in connection with storage for irrigation.

In the Territory of Hawaii the unit most commonly used in measuring water is the "million gallons." This is used with two meanings—(1) to indicate a rate of flow and (2) to express an actual quantity of water. In the former sense "million gallons per day" is inferred, 1,000,000 gallons being taken as the unit of quantity and 24 hours as the unit of time. With this meaning the term is generally used in connection with pumping and irrigation. In the latter sense "million gallons" as an absolute quantity is used in the measurement of storage capacities of reservoirs.

The following convenient approximate relations exist between second-feet, million gallons per day, and acre-feet: 1 second-foot flowing 24 hours equals about 2 acre-feet; 1,000,000 gallons equals about 3 acre-feet; and 1 second-foot equals approximately two-thirds million gallons per day.

"Man's water" is an irrigator's term also in common use in Hawaii. It signifies the amount of water that one irrigator can properly handle in the field. It varies greatly, being dependent upon the condition of

Digitized by Google

the furrows, the age of the crop, and the skill and individuality of the irrigator.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

Table for converting discharge in second-feet into run-off in acre-feet.

Discharge (second-feet).	Run-off (acre-feet).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1	1.983	55.54	57.52	59.50	61.49
2	3.967	111.1	115.0	119.0	123.0
3	5.950	166.6	172.6	178.5	184.5
4	7.934	222.1	230.1	238.0	246.0
5	9.917	277.7	287.6	297.5	307.4
6	11.90	333.2	345.1	357.0	368.9
7	13.88	388.8	402.6	416.5	430.4
8	15.87	444.3	460.2	476.0	491.9
9	17.85	499.8	517.7	535.5	553.4

NOTE.—For a part of a month multiply discharge for one day by the number of days.

1,000,000 United States gallons per day equals 1.55 second-feet.

1,000,000 United States gallons equals 3.07 acre-feet.

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,317 gallons for one day.

1 second-foot for one year (365 days) covers 1 square mile 1.131 feet, or 13.572 inches, deep.

1 second-foot for one year (365 days) equals 31,536,000 cubic feet.

1 second-foot for one year (365 days) equals 724 acre-feet.

1 second-foot equals about 1 acre-inch per hour.

1 second-foot for one day covers 1 square mile 0.03719 inch deep.

1 second-foot for one day equals 1.983 acre-feet.

1,000,000 cubic feet equals 22.95 acre-feet.

1 acre-foot equals 325,850 gallons.

1 inch deep on 1 square mile equals 2,323,200 cubic feet.

1 inch deep on 1 square mile equals 0.0737 second-foot per year.

1 foot equals 0.3048 meter.

1 mile equals 1.60935 kilometers.

1 mile equals 5,280 feet.

1 acre equals 0.4047 hectare.

1 acre equals 43,560 square feet.

1 acre equals 209 feet square, nearly.

1 square mile equals 2.59 square kilometers.

1 cubic foot equals 0.0283 cubic meter.

1 cubic foot equals 7.48 gallons.

1 cubic foot of water weighs 62.5 pounds.

1 cubic meter per minute equals 0.5886 second-foot.

1 horsepower equals 550 foot-pounds per second.

1 horsepower equals 76.0 kilogram-meters per second.

1 horsepower equals 746 watts.

1 horsepower equals 1 second-foot falling 8.80 feet.

1½ horsepower equals about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = net horsepower on water wheel realizing 80 per cent of theoretical power.

Digitized by Google

OFFICE METHODS OF COMPUTING AND STUDYING DISCHARGE AND RUN-OFF.

At the end of each year the field or base data for current-meter gaging stations, consisting of water-stage record sheets, daily gage heights, discharge measurements, and notes from observers' books, are assembled. The measurements are plotted on cross-section paper, and rating curves are drawn wherever feasible. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharge, and from these applications the tables of monthly discharge and run-off are computed.

Rating curves are drawn and studied with special reference to the class of channels which they represent. The discharge measurements for all classes of stations, when plotted with gage heights in feet as ordinates and discharge in million gallons per day as abscissas, define rating curves which are generally more or less parabolic in form.

For every rating table the following assumptions are made for the period of application of the table: (*a*) That the discharge is a function of and increases gradually with the stage; (*b*) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating, as stated in the footnote to each table, is not applicable for periods during which the channel was obstructed; (*c*) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock and is not subject to the deposits of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will, for all practical purposes, be a true index of the discharge. Discharge measurements made at such stations usually plot within 2 or 3 per cent of the mean discharge curve, and the rating developed from that curve represents a very high degree of accuracy.

Class 2 comprises mainly stations on rough, mountainous streams with steep slopes. The beds of such streams are, as a rule, comparatively permanent during low and medium stages, and when the flow is sufficiently well defined by an adequate number of discharge

Digitized by Google

measurements before and after each flood the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the period of actual change in conditions of flow.

Class 3 includes those stations where the stream bed is of a shifting character, or the controlling section below the gage frequently changes, owing to cutting out by the current and the filling in of sand, gravel, and drift. In some places in Hawaii changes are caused by the growth of vegetation in the stream bed. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly from the measurements made in the current year, the engineer being guided largely by the history of the station and the following general law: If all measurements ever made at a station of this class are plotted on cross-section paper they will define a mean curve which may be called a standard curve. It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to ordinates or gage heights. This law of the parallelism of rating curves is the fundamental basis of all ratings and estimates at stations with semipermanent and shifting channels. It is not absolutely correct, but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. This law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut, or fill, or both, at or near the measuring section. For all except small streams the changes in section usually occur at the bottom. The following simple but typical examples illustrate this law:

(*a*) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases discharge, area, and velocity for any gage height. In practice, however, such ideal conditions rarely exist.

(*b*) If a cut or fill occurs at the measuring section, there is a marked tendency toward decrease or increase, respectively, of the velocity.

Digitized by Google

In other words, the velocity has a compensating effect, and if the compensation is exact at all stages the discharge at a given stage will be the same under both the new and the old conditions.

(*c*) If change along the crest of a weir or rocky control is uniform, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve with respect to their ordinates.

In actual practice, of course, such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another, and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of rating curves. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, boils, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that in the lack of other data to the contrary the utilization of this law will yield the most accurate results.

At low or medium stages slight changes of an oscillating character are usually averaged by a mean curve drawn among them parallel to the standard curve, and if the individual measurements do not vary more than 5 per cent from the rating curve the results are considered good for stations of this class.

Class 4 comprises stations on streams that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency ranging from a measurement every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. These measurements are plotted and a mean or standard curve drawn among them. It is assumed that there is a different rating curve for every day of the year and that the curves are parallel to the standard curve with respect to their ordinates. On the day of a measurement the rating curve for that day passes through that measurement. For days between successive measurements it is assumed that the rate of change is uniform, and hence the ratings for the intervening days are equally spaced between the ratings passing through the two measurements. This method must be modified or abandoned altogether under special conditions. Personal judgment and a knowledge of the conditions involved can alone dictate the course then to be pursued.

Digitized by Google

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing data are filled in, so far as feasible, by means of comparison with records for adjacent streams. The attempt is made to complete records for years or periods of discharge, thus eliminating fragmentary and disjointed records. Full notes accompanying such estimates follow the daily and monthly discharge tables.

EXPLANATION OF TABLES.

For each current-meter gaging station are given in general the following data: Description of station, list of discharge measurements, table of daily discharge, table of monthly and yearly discharge, and run-off in acre-feet and million gallons.

All rates of flow are expressed as million gallons per day.

In addition to statements regarding the location and installation of current-meter stations, the descriptions give information in regard to any conditions which may affect the constancy of the relation of gage height to discharge, covering such points as shifting channels and backwater; also information regarding diversions which decrease the total flow at the measuring section. Statements are also made regarding the utilization of the water, the maximum and minimum stage and discharge, and the accuracy of the data.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, gage height, and discharge in second-feet and million gallons per day.

The table of daily discharge gives the discharge in million gallons per day corresponding to the observed gage height as determined from the rating table, the number of significant figures used varying with the size of the discharge.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently larger than given in the maximum column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The columns headed "Mean" give the average flow in million gallons per day and in cubic feet per second during the month. The "Total in million gallons" and "Total in acre-feet" given in the columns under these heads are computed from the mean discharge in million gallons per day.

Digitized by Google

Owing to the volcanic formation of the Hawaiian Islands there is such wide diversity in the character and porosity of the rocks of the various drainage basins that the determination of a general relation between rainfall and run-off is of no value. For this reason information concerning drainage areas has been omitted in the station descriptions.

ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

The accuracy of stream-flow data depends (1) on permanence of the relation between discharge and stage and (2) on the accuracy of observations of stage, measurements of discharge, and interpretation of data.

The accuracy recorded in the station description is based on the accuracy of the rating curve, the reliability of the gage-height record, the range of the fluctuation in stage, and knowledge of local conditions. The use of "good," "fair," "poor," or "approximate" indicates that the probable errors are within 5, 10, 15, and 20 per cent, respectively.

It should be borne in mind that the observations in each succeeding year may be expected to throw new light on records already collected and published.

DIVISION OF WORK.

The data were collected and prepared for publication under the direction of G. K. Larrison, district engineer, Honolulu, Hawaii, by C. T. Bailey, office engineer, W. V. Hardy, R. C. Rice, R. D. Klise, H. A. R. Austin, D. E. Horner, E. E. Goo, and John Kaheaku.

GAGING STATIONS MAINTAINED IN HAWAII.

The following list comprises the gaging stations maintained in Hawaii by the United States Geological Survey and cooperative parties. The stations are arranged by stream basins and appear in systematic order for the several islands, tributaries of main streams being indicated by indention. The dates show the years or parts of years for which records are available. A dash following the date indicates that the station was being maintained June 30, 1917.

KAUAI ISLAND.

Waimea River near Waimea, 1910–
- Poomau River:
  - Kawaikoi Stream near Waimea, 1909–1917.
    - Waiakoali Stream near Waimea, 1909–1912.
  - Mohihi Stream near Waimea, 1909–1912.
- Waiahulu Stream near Waimea, 1916–
- Koaie Stream near Waimea, 1916–
- Waialae River near Waimea, 1910–1916.
- Waialae River at elevation 800 feet, near Waimea, 1916–

Digitized by Google

Waimea River tributaries—Continued.
Kekaha ditch at Camp No. 1, near Waimea, 1910–1915.
Kekaha ditch at flume No. 3, near Waimea, 1910–1912.
Kekaha ditch at flume No. 4, near Waimea, 1916–
Kekaha ditch at siphon near Waimea, 1910–1912.
Kekaha ditch at tunnel No. 12, near Waimea, 1910–1914.
Kekaha ditch below tunnel No. 12, near Waimea, 1916–
Waimea ditch near Waimea, 1911–1913, 1916–
Kamenehune ditch near Waimea, 1911–
Makaweli River near Waimea, 1911–1917.
Halekua Stream near Waimea, 1912–13.
Olokele River near Waimea, 1915–1917.
Olokele ditch at tunnel No. 12, near Makaweli, 1904–1917.
Olokele ditch at weir, near Makaweli, 1912–1917.
Poowaiomahaihai ditch near Waimea, 1911–1913.
Hanapepe River above Hanapepe Falls, near Eleele, 1911–12.
Hanapepe River at Koula, near Eleele, 1910–1916.
Hiloa ditch near Eleele, 1911–1915.
East Branch Hanapepe River below Hanapepe Falls, near Eleele, 1911–12.
Hanapepe ditch at Hanapepe Falls, near Eleele, 1911–1915.
Hanapepe ditch at Koula, near Eleele, 1910–
Hanapepe ditch at weir near Hanapepe, 1910–
Huleia River near Lihue, 1912–1915.
Hanamaulu River at Kapaia, near Lihue, 1911–1914.
Wailua River:
South Fork of Wailua River at siphon near Lihue, 1910–11.
South Fork of Wailua River near Lihue, 1911–
Hanamaulu ditch near Lihue, 1910–
Lihue ditch near Lihue, 1910–
North Fork of Wailua River near Lihue, 1910–1914.
North Fork of Wailua River at elevation 650 feet near Lihue, 1914–
Kanaha ditch near Lihue, 1910–
East Branch of North Fork of Wailua River near Lihue, 1912–
Uhau Iole Stream at elevation 750 feet, near Lihue, 1912.
Keahua Stream at elevation 750 feet, near Lihue, 1912.
Kawi Stream at elevation 750 feet, near Lihue, 1912.
Konohiki Stream at Makakualele weir (mauka) near Kapaa, 1911–1913.
Kaehulua Stream at Kuhinoa (mule stable) weir, near Kapaa, 1911–1913.
South Fork of Kaehulua Stream at Wainamuamu weir, near Kapaa, 1911–12.
North Fork of Kaehulua Stream at Wainamuamu weir, near Kapaa, 1911–1913.
Kapaa River near Kealia, 1910–
Akulikuli Spring near Kealia, 1911–1913.
Kapahi ditch near Kealia, 1909–
Tunnel ditch at Kapahi, near Kapaa, 1909–1911.
Kapaa ditch at Kapahi, near Kapaa, 1909–1911.
Pipe ditch at Kapahi, near Kapaa, 1909–1911.
Kealia Stream:
Kaneha ditch near Kealia, 1909–1913.
Anahola River at elevation 1,140 feet near Kealia, 1912.
Anahola River near Kealia, 1910. .1912–
Anahola River at Kiokala dam, near Kealia, 1910–1912.
Anahola ditch above Kaneha reservoir, near Kealia, 1914–
Anahola ditch at Kiokala, near Kealia, 1909–1914.
Anahola ditch at Makai weir, near Kealia, 1909–1911.

Digitized by Google

Kalihiwai River near Hanalei, 1914–
Kalihiwai River near Kilauea, 1912–1914.
Hanalei River at elevation 625 feet, near Hanalei, 1914–
Hanalei River near Hanalei, 1911–
China ditch near Hanalei, 1911–
Kuna ditch near Hanalei, 1912–13. 1916–
Lumahai River near Hanalei, 1914–1917.
Lumahai River near Wainiha, 1912.
Waioli Stream near Hanalei, 1914–
Wainiha River near Hanalei, 1914–1917.
Wainiha River, East Channel, near Wainiha, 1912–1916.
Wainiha River, West Channel, near Wainiha, 1911–1916.
Wainiha canal at intake, near Wainiha, 1910–1916.
Wainiha canal at tunnel No. 18, near Wainiha, 1911.
Wainiha canal at tailrace, near Wainiha, 1911.

OAHU ISLAND.

Kalihi Stream near Honolulu, 1913–
Nuuanu Stream at Laukaha weir in upper Nuuanu Valley, near Honolulu, 1903, 1910–1913.
Nuuanu Stream below Reservoir No. 2 wasteway, near Honolulu, 1913–
Nuuanu Stream at Kuakini Street, near Honolulu, 1911–12.
Lulumaha ditch at upper Nuuanu reservoir, near Honolulu, 1911–1913.
Pauoa Stream at upper Pauoa Valley, near Honolulu, 1911–1913.
Kahuawai Spring, near Honolulu, 1912–1914.
Manoa Stream at upper Manoa Valley, near Honolulu, 1910–1913.
Manoa Stream at College of Hawaii, near Honolulu, 1909–
West Branch of Manoa Stream near Honolulu, 1913–
East Branch of Manoa Stream near Honolulu, 1913–
East Manoa ditch near Honolulu, 1915–1916.
Palolo Stream:
Pukele Stream at Mahoe springs, near Honolulu, 1912–13.
Waiomao Stream at upper Palolo Valley, near Honolulu, 1911–1913.
Waiomao Stream above Pukele, near Honolulu, 1911–12.
Waimanalo ditch below main reservoir, near Waimanalo, 1912–13.
Pump ditch near Waimanalo, 1912.
Makawao ditch near Kailua, 1912–1916.
Kailua Stream near Kailua, 1912–1916.
Wong Leong's ditch near Kailua, 1912–1916.
Makawao Stream near Kailua, 1912–1916.
Makawao Spring near Kailua, 1914–1916.
Kaimi Stream near Kailua, 1912–1916.
Main spring near Kailua, 1914–1916.
Kamakalepo Stream near Kailua, 1912–1916.
Pohakea Stream near Kailua, 1912–1914.
Kahanaiki Stream in Kailua Valley, near Kailua, 1912.
Kahanaiki Stream near Kailua, 1914–1916.
South Branch of Kahanaiki Stream near Kailua, 1913–14.
North Branch of Kahanaiki Stream near Kailua, 1913–14.
Kahanaiki ditch in Kailua Valley, near Kailua, 1912–13.
Kaneohe Stream near Kaneohe, 1914–1916.
Young Mau ditch near Kaneohe, 1914–1916.
Ahlo ditch near Kaneohe, 1914–1916.
Hooleinaiwa Stream near Kaneohe, 1914–1916.
Piho Stream near Kaneohe, 1914–1916.

Digitized by Google

Kaneohe Stream tributaries—Continued.
Kuou Stream near Kaneohe, 1914–1916.
Kuou ditch near Kaneohe, 1914–1916.
Luluku Stream near Kaneohe, 1914–1916.
North Luluku ditch near Kaneohe, 1914–1916.
Kawa Stream near Kaneohe, 1914–1916.
Heeia Stream:
Wing Wo Tai ditch near Heeia, 1914–1916.
Hop Tuck ditch near Heeia, 1914–1916.
Lee ditch near Heeia, 1914–1916.
Haiku Stream near Heeia, 1914–
Reservoir ditch near Heeia, 1914–1916.
Waipio ditch near Heeia, 1914–1916.
Iolekaa Stream near Heeia, 1914–1916.
Waiahole Stream below power house, near Waiahole, 1915.
Waiahole Stream near Waiahole, 1911–1916.
Waiahole Stream at Waiahole, near Waikane, 1911–12.
Waihi Stream near Waikane, 1911.
Halona Stream near Waikane, 1911.
Waianu Stream near Waikane, 1911.
Waikane Stream near Waikane, 1911–1912.
Kahana Stream near Kahana, 1914–1917.
East Branch of Kahana Stream near Kahana, 1914–1917.
Punaluu Stream at elevation 539 feet, near Punaluu, 1915–
Punaluu Stream at elevation 250 feet, near Punaluu, 1914–
Punaluu Stream near Hauula, 1906–7.
Waihoi Stream near Punaluu, 1915–
Kaluanui Stream near Hauula, 1906–7, 1915–17.
Kaipapau Stream near Hauula, 1906–7.
Koloa Stream near Laie, 1914–
Wailele Stream near Laie, 1914–
East Branch of Kahawainui Stream near Laie, 1914–
East Branch of Malaekahana Stream near Kahuku, 1914–
Middle Branch of Malaekahana Stream near Kahuku, 1914–
Kaukonahua Stream:
North Fork of Kaukonahua Stream near Wahiawa, 1911.
Right Branch of North Fork of Kaukonahua Stream near Wahiawa, 1913–
Left Branch of North Fork of Kaukonahua Stream near Wahiawa, 1913–
South Fork of Kaukonahua Stream above United States Army reservoir, near Wahiawa 1911, 1913–1917.
United States Army ditch at reservoir, near Wahiawa, 1914–15.
South Fork of Kaukonahua Stream below United States Army reservoir near Wahiawa, 1914–
Wahiawa reservoir ditch near Wahiawa, 1910–11.

MAUI ISLAND.

West Maui.

Iao Stream near Wailuku, 1910–1915.
Maniania ditch near Wailuku, 1909–1913.
Waiehu Stream:
South Waiehu Stream near Wailuku, 1910–1917.
South Waiehu ditch near Wailuku, 1912–1915.
North Waiehu Stream near Wailuku, 1912–1917.
North Waiehu ditch near Wailuku, 1910–11, 1916–

Digitized by Google

Waihee Stream near Waihee, 1910–1912, 1913–1917.
Waihee canal near Waihee, 1910–1912.
Waihee canal at weir, near Wailuku, 1911–12.
Spreckels ditch near Waihee, 1910–1913.
Spreckels ditch at Waiale weir, near Wailuku, 1910–11.
Kahakuloa Stream at Kahakuloa, near Waihee, 1912–13.
Kahakuloa Stream near Honokahau, 1913–14.
Honokahau Stream near Honokahau, 1913–
Honokahau ditch at intake, near Honokahau, 1907–1913.
Honokahau ditch above Honolua Stream, near Honokahau, 1910–11.
Honokahau ditch at Honokawai weir, near Lahaina, 1910–1912.
Honolua Stream at Honolua ranch, 1911.
Honolua Stream near Honokahau, 1913–
Honolua ditch near Honokahau, 1911–12.
Honokawai Stream near Lahaina, 1911; 1912–
Honokawai Stream at weir No. 1, near Lahaina, 1901.
Honokawai ditch near Lahaina, 1912–
Kahoma Stream near Lahaina, 1911–12; 1913–
Kahoma Stream at weir No. 1, near Lahaina, 1901.
Kahoma Stream at weir No. 2, near Lahaina, 1901.
Kahoma development tunnel near Lahaina, 1911–
Lahainaluna Stream above pipe line intake, near Lahaina, 1916–
Lahainaluna Stream near Lahaina, 1911–1916.
Lahainaluna weir No. 1 near Lahaina, 1901.
Lahainaluna weir No. 2 near Lahaina, 1901.
Lahainaluna ditch near Lahaina, 1913–14.
Kauaula Stream near Lahaina, 1912; 1913–
Kauaula Stream at weir No. 3, near Lahaina, 1901.
Kauaula ditch near Lahaina, 1911–
Kauaula Stream, North Fork, at weir No. 1, near Lahaina, 1901.
Kauaula Stream, South Fork, at weir No. 2, near Lahaina, 1901.
Launiupoko Stream near Lahaina, 1911–1917.
Olowalu Stream near Olowalu, 1913–1916.
Olowalu ditch near Olowalu, 1911–
Ukumehame Stream near Olowalu, 1911–12; 1913–
Waikapu Stream near Waikapu, 1910–1917.
Palolo (Everett) ditch near Waikapu, 1910–1917.
South Side Waikapu ditch near Waikapu, 1910–1917.

East Maui.

Koolau ditch region:
Hanawi Stream near Nahiku, 1914–15.
West Kopiliula Stream near Keanae, 1914–1917.
East Wailuaiki Stream near Keanae, 1913–1917.
West Wailuaiki Stream near Keanae, 1914–1917.
East Wailuanui Stream near Keanae, 1914–1917.
West Wailuanui Stream near Keanae, 1913–1917.
Koolau ditch near Keanae, 1910–1912.
Koolau ditch at Alo division weir, near Huelo, 1908–1911.
Spreckels ditch region:
Honomanu Stream near Keanae, 1913–
Haipuaena Stream near Huelo, 1910–
Puohakamoa Stream near Huelo, 1910–
Alo Stream near Huelo, 1910–

Digitized by Google

Spreckels ditch region—Continued.
Waikamoi Stream near Huelo, 1910–
Oopuola Stream near Huelo, 1910–1915.
Spreckels ditch at station No. 1, near Huelo, 1910–1913.
Spreckels ditch at station No. 2, near Huelo, 1911–1913.
Spreckels ditch at station No. 3, near Huelo, 1910–1913.
Spreckels ditch at station No. 4, near Huelo, 1910–1913.
Spreckels ditch at station No. 5, near Huelo, 1911–1913.
Spreckels ditch at station No. 6, near Huelo, 1911–1913.
Spreckels ditch at station No. 7, near Huelo, 1911–1912.
Spreckels ditch at station No. 8, near Huelo, 1911–1913.
Center ditch region:
Center ditch near Huelo, 1910–1912.
Hamakua ditch region:
Nailiilihaele Stream near Huelo, 1910–1912; 1913–
Kailua Stream near Huelo, 1910–1912; 1913–
Oanui Stream near Huelo, 1910–11; 1913–1916.
Hoolawaliilii Stream near Huelo, 1911–
Hoolawanui Stream near Huelo, 1911–
Honopou Stream near Huelo, 1910–
Halehaku Stream at dam, near Huelo, 1910–11.
Halehaku Stream weir near Huelo, 1910–1912.
Opana Stream near Huelo, 1910–1912.
Opana ditch near Huelo, 1910–1912.
New Hamakua ditch at Nailiilihaele weir, near Huelo, 1910–1912.
New Hamakua ditch at Halehaku weir, near Huelo, 1910–
New Hamakua ditch at station No. 1, near Huelo, 1912.
New Hamakua ditch at station No. 2, near Huelo, 1912.
New Hamakua ditch at station No. 3, near Huelo, 1912.
New Hamakua ditch at station No. 4, near Huelo, 1912.
New Hamakua ditch at station No. 5, near Huelo, 1912.
Old Hamakua ditch at Opana weir, near Huelo, 1910–
Kaluanui ditch at Puuomalei, near Hamakuapoko, 1910–1912.
Lowrie ditch at Opana weir, near Huelo, 1910–
Haiku ditch at Peahi weir, near Huelo, 1910–

HAWAII ISLAND.

Hilo group:
81 stations at elevation 2,700 feet, in forest back of Hilo, 1911–1913.
Wailuku River near Hilo, 1911–1913.
Honolii River at Kaiwiki, near Hilo, 1911–1913.
Honolii ditch at Kaiwiki, near Hilo, 1911.
Kawainui River at Kawainui, near Pepeekeo, 1911–12.
4 stations at Piihonua, near Hilo, 1912.
Hamakua group:
Waipio River below Koiawe, near Waipio, 1911–12.
Waipio River below Waima, near Waipio, 1911–12.
Waipio River at elevation 360 feet, near Waipio, 1901–2.
New Hamakua ditch at Waima Stream, near Waipio, 1912.
Lower Hamakua ditch at main weir, near Kukuihaele, 1910–
Upper Hamakua ditch at main weir, at Puualala, Waimea, 1913–
Kawainui Branch of Waipio River, near Waipio, 1911–12.
Kawainui Stream at elevation 2,120 feet, near Waipio, 1901–2.
Kawainui Stream at elevation 1,435 feet, near Waipio, 1901–2.

Digitized by Google

Hamakua group—Continued.
Waipio River tributaries—Continued.
Kawainui Stream at elevation 775 feet, near Waipio, 1901–2.
Branch No. 3 of Kawainui Stream at elevation 1,700 feet, near Waipio, 1901–2.
Branch No. 2 of Kawainui Stream at elevation 1,405 feet, near Waipio, 1901–2.
Branch No. 1 of Kawainui Stream at elevation 1,380 feet, near Waipio, 1901–2.
Alakahi Stream at elevation 1,200 feet, near Waipio, 1901–2.
Alakahi Stream at elevation 730 feet, near Waipio, 1901–2.
Koiawe Stream at elevation 1,120 feet, near Waipio, 1901–2.
Koiawe Stream at elevation 610 feet, near Waipio, 1901–2.
Waima Stream at elevation 790 feet, near Waipio, 1901–2.
Waima Stream at elevation 385 feet, near Waipio, 1901–2.
Kohala group:
Honokane Stream:
East Branch of Honokane Stream at elevation 1,300 feet, near Honokane, 1901.
East Branch of Honokane Stream elevation at 770 feet, near Honokane, 1901.
West Branch of Honokane Stream at elevation 1,370 feet, near Honokane, 1901.
West Branch of Honokane Stream at elevation 775 feet, near Honokane, 1901.
Kohala ditch at Awini weir, near Kohala, 1907–
Kohala ditch at Niulii weir, near Kohala, 1907–
Kehena ditch at Honokane mauka, near North Kohala, 1912–13.

GAGING-STATION RECORDS.

ISLAND OF KAUAI.

WAIMEA RIVER NEAR WAIMEA, KAUAI.

LOCATION.—250 feet above ford, about 2 miles north of Waimea.

RECORDS AVAILABLE.—July 9, 1910, to June 30, 1917.

GAGE.—Vertical and inclined staff installed October 5, 1911. July 9, 1910, to October 4, 1911, staff gage about 1 mile downstream.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 500 feet above and below gage; banks high; bed of stream sandy. Control composed of sand, gravel, and boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 18.0 feet at 4 p. m., December 18 (discharge, approximately 10,000 million gallons per day, or 15,500 second-feet); minimum stage recorded, 4.4 feet September 3–7 and 9 (discharge, 1.0 million gallons per day, or 1.55 second-feet). Maximum stage recorded, 18.8 feet at 4.30 p. m., January 25, 1916 (discharge, computed from extension of the rating curve, approximately 10,700 million gallons per day, or 16,600 second-feet); channel practically dry at times, as all water is diverted above.

DIVERSIONS.—Large number of diversions above station.

REGULATION.—By diversions.

UTILIZATION.—All water passing this station is wasted, as none is diverted below.

ACCURACY.—Gage read twice daily. Records fair for all stages below 1,500 million gallons per day.

Digitized by Google

Discharge measurements of Waimea River near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 30	W. V. Hardy	4.35	0.95	0.6
Sept. 25	do	5.69	104	67
Oct. 25	D. E. Horner	6.90	470	304
Nov. 18	W. V. Hardy	6.73	411	265
Dec. 2	D. E. Horner	6.48	315	204
Jan. 26	do	6.14	205	133
Feb. 12	do	5.62	85	55
27	do	5.54	77	50
Mar. 7	do	6.05	184	119
17	do	6.54	357	231
Apr. 23	W. V. Hardy	5.85	134	86
May 24	do	5.45	77	50
June 13	D. E. Horner	5.36	63	41

Daily discharge, in million gallons, of Waimea River near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	80	1.5	1.5	2.0	18	1,210	208	74	51	119	336	186
2	94	1.5	1.5	2.0	14	186	260	1,080	38	94	119	87
3	102	74	1.0	1.5	14	87	246	260	56	74	46	68
4	197	27	1.0	2.0	137	46	232	220	176	62	30	51
5	21	27	1.0	3.0	702	62	156	197	186	46	24	146
6	74	4.0	1.0	336	156	34	110	186	156	38	24	166
7	3.0	2.5	1.0	62	436	275	62	156	146	38	18	146
8	2.5	2.0	1.5	18	530	186	51	119	186	30	14	119
9	2.5	2.0	1.0	6.0	128	275	46	94	260	38	14	74
10	2.5	2.0	6.0	6.0	68	336	208	80	94	34	14	51
11	2.0	2.5	2.0	6.0	34	74	166	80	94	962	12	38
12	2.0	4.0	2.5	6.0	128	68	137	62	80	119	10	30
13	16	10	2.0	10	34	102	119	56	186	80	7.0	30
14	12	7.0	2.0	12	21	80	94	436	137	68	8.5	30
15	24	12	2.0	8.5	21	46	46	156	290	56	10	21
16	102	7.0	2.0	8.5	42	34	401	128	511	51	7.0	87
17	102	3.0	2.0	12	21	176	634	94	232	62	8.5	110
18	110	21	2.0	10	384	3,000	208	800	336	34	1,050	94
19	16	146	12	10	68	775	119	305	726	27	570	68
20	6.0	87	34	27	24	384	1,600	176	2,960	24	232	34
21	3.0	30	38	12	679	220	401	128	1,080	21	102	24
22	3.0	6.0	6.0	10	146	401	232	128	656	18	74	21
23	3.0	5.0	56	10	62	473	166	87	384	62	80	18
24	3.0	3.0	7.0	42	38	454	436	80	305	119	51	14
25	2.5	2.5	27	336	18	473	176	68	166	68	46	12
26	2.0	2.0	12	51	74	401	146	56	220	74	42	10
27	2.0	5.0	30	12	51	232	128	51	186	56	38	10
28	2.0	3.0	7.0	305	62	119	166	46	137	46	102	10
29	2.0	2.0	6.0	679	232	208	186	.....	94	34	119	10
30	2.0	2.0	2.5	87	290	156	119	.....	87	27	232	10
31	2.0	2.0	.....	46	.....	110	87	.....	74	.....	232	.....

NOTE.—Discharge determined from rating curves well defined below 500 million gallons per day and fairly well defined below 1,500 million gallons per day, applicable July 1 to May 18 and May 19 to June 30.

Digitized by Google

Monthly discharge of Waimea River near Waimea, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	197	2.0	32.2	49.8	997	3,060
August	146	1.5	16.3	25.2	506	1,550
September	56	1.0	9.02	14.0	270	830
October	679	1.5	69.0	107	2,140	6,560
November	702	14	154	238	4,630	14,200
December	3,000	34	345	534	10,700	32,800
January	1,600	46	237	367	7,350	22,500
February	1,080	46	193	299	5,400	16,600
March	2,960	38	332	514	10,300	31,600
April	962	18	86.0	133	2,580	7,920
May	1,050	7.0	118	183	3,670	11,200
June	186	10	59.2	91.6	1,780	5,450
The year	3,000	1.0	138	214	50,300	154,000

KAWAIKOI STREAM NEAR WAIMEA, KAUAI.

LOCATION.—Eight miles northeast of Knudsen's mountain house and about 27 miles, by horse trail, north of Waimea.

RECORDS AVAILABLE.—April 13, 1909, to June 30, 1917.

GAGE.—Barrett & Lawrence water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below station; banks high and wooded. Control composed of rock ledge and large boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 15.2 feet December 18, 1916 (discharge not determined); minimum stage recorded, 1.55 feet October 3 to 6, 1913 (discharge, 2.6 million gallons per day, or 4 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane, rice, and taro; power development and domestic supply.

ACCURACY.—Records fair below 40 million gallons per day. Records after December 17 too incomplete to warrant publication.

Discharge measurements of Kawaikoi Stream near Waimea, Kauai, during the year ending June 30, 1917.

[Made by D. E. Horner.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Sept. 1	1.95	8.8	5.7	Feb. 1	1.94	17.5	11
Oct. 2	1.89	5.8	3.8	Apr. 2	1.85	15.6	10
Dec. 8	2.36	27	18	May 24	1.90	18.6	12

Digitized by Google

Daily discharge, in million gallons, of Kawaikoi Stream, near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	11	.....	5.0	9.5	60	16	51	.....	9.5	32	5.9	51
2	.....	29	5.0	5.0	9.5	51	17	32	.....	5.9	19	5.9	34
3	.....	39	5.0	5.0	9.5	39	18	27	.....	9.5	14	5.9	.....
4	.....	27	5.0	5.0	9.5	36	19	12	.....	48	29	11	.....
5	.....	19	5.9	32	9.5	27	20	9.5	.....	34	32	12	.....
6	.....	11	5.0	48	11	19	21	9.5	.....	29	34	8.0	.....
7	.....	19	19	17	12	19	22	7.0	.....	17	60	12	.....
8	.....	17	11	130	14	19	23	7.0	.....	19	27	17	.....
9	9.5	9.5	7.0	144	9.5	60	24	5.9	.....	16	54	23	.....
10	12	7.0	5.0	48	27	27	25	5.9	.....	17	48	42	.....
11	14	7.0	23	117	14	32	26	5.0	.....	9.5	19	199	.....
12	11	23	12	92	8.0	60	27	5.0	.....	12	11	51	.....
13	11	27	5.9	34	48	39	28	7.0	.....	8.0	17	32	.....
14	23	.....	5.0	25	11	60	29	5.0	.....	7.0	48	25	.....
15	25	.....	8.0	32	7.0	54	30	5.0	.....	5.9	14	48	.....
							31	7.0	.....	.....	9.5	.....	.....

NOTE.—Discharge determined from rating curve fairly well defined below 40 million gallons per day. Gage heights not recorded on days for which discharge is not given.

Monthly discharge of Kawaikoi Stream near Waimea, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July 9–31	51	5.0	13.3	20.6	306	939
August 1–13	39	7.0	18.9	29.2	246	754
September 2–30	48	5.0	12.7	19.7	369	1,130
October	144	5.0	3.89	6.02	121	370
November	199	5.9	23.6	36.5	707	2,170
December 1–17	60	19	40.4	62.5	687	2,110

WAIAHULU STREAM NEAR WAIMEA, KAUAI.

LOCATION.—In Waimea Canyon, half a mile above confluence with Koaie Stream, 12 miles north of Waimea.

RECORDS AVAILABLE.—October 27, 1915, to October 21, 1916.

GAGE.—Gurley printing water-stage recorder. Gage shelter destroyed by flood December 18, 1916, and recorder lost.

DISCHARGE MEASUREMENTS.—Made from cable or by wading.

CHANNEL AND CONTROL.—One channel at all stages; straight for 200 feet above and below gage; banks high. Control composed of large boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Flood December 18, 1916, reached a stage of about 15 feet (discharge not estimated); minimum stage recorded, 1.8 feet October 3, and 4, 1916 (discharge, 13 million gallons per day, or 26 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—For irrigation of sugar cane, rice, and taro, and for power and domestic supply.

ACCURACY.—Records fair below 40 million gallons per day.

Digitized by Google

Discharge measurements of Waiahulu Stream near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 18	D. E. Horner	2.30	48	31
19	do	2.14	41	26
Aug. 9	do	1.96	28	18
11	do	1.91	25	16
Oct. 22	do	2.02	35	23
23	do	2.25	50	32
Mar. 27	W. V. Hardy	3.12	63	41

Daily discharge, in million gallons, of Waiahulu Stream near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Date.	July.	Aug.	Sept.	Oct.
1	102	18	16	14	16	77	26	18	14
2	50	29	14	14	17	54	22	16	14
3	59	54	14	13	18	46	59	14	14
4	77	32	14	13	19	26	26	54	18
5	32	29	14	59	20	22	68	43	18
6	24	19	14	112	21	22	50	46	18
7	22	19	19	36	22	22	32	24	.....
8	19	24	19	22	23	18	22	29	.....
9	19	18	16	29	24	18	18	24	.....
10	19	16	14	24	25	18	18	24	.....
11	24	16	22	18	26	16	18	19	.....
12	22	22	22	18	27	16	16	22	.....
13	22	32	16	22	28	16	16	18	.....
14	32	22	14	18	29	16	18	16	.....
15	32	40	16	16	30	16	18	14	.....
					31	16	18	.....	.....

NOTE.—Discharge determined from rating curve fairly well defined below 40 million gallons per day. Gage-height records Oct. 22 to Dec. 18 lost with recorder.

Monthly discharge of Waiahulu Stream near Waimea, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	102	16	31.4	48.6	974	2,990
August	68	16	26.9	41.6	835	2,560
September	54	14	20.8	32.2	625	1,920
October 1–21	112	13	25.0	38.7	524	1,610
The period	.....	.....	.....	.....	2,960	9,080

KOAIE RIVER NEAR WAIMEA, KAUAI.

LOCATION.—About one-third mile above confluence with Waimea River, 12 miles north of Waimea.

RECORDS AVAILABLE.—October 21, 1915, to June 30, 1917; record fragmentary.

GAGE.—Gurley printing water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below gage; banks steep and high. Control composed of large boulders; shifting.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.7 feet at 3 a. m. March 4 (discharge, approximately 650 million gallons per day, or 1,000 second-feet); minimum stage recorded 2.3 feet June 25–30 (discharge, 16 million gallons per day, or 25 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane, rice, and taro and for power development and domestic supply.

ACCURACY.—Records fair for all stages.

Discharge measurements of Koaie River near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 19	W. V. Hardy	2.32	42	27
Aug. 9	D. E. Horner	2.15	36	24
10	do	2.08	28	18
Oct. 22	do	2.20	33	22
23	do	2.53	56	36
Mar. 29	W. V. Hardy	2.50	42	27
May 22	D. E. Horner	2.76	74	48

Daily discharge, in million gallons, of Koaie River near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Mar.	Apr.	May.	June.
1		20	17	55		108	16	51
2		35	17	60		39	16	35
3		60	20	26		25	16	28
4		32	20	20		39	16	32
5		32	28	20		35	19	43
6		24	22	19		28	28	39
7			26	19		22	150	51
8		22	20	24		22	144	43
9		19	18	24		22		28
10		19	18	20		19		25
11		19	19	24		19		25
12		19	17	24		28		22
13		24	17			39		22
14		22	24			35		22
15		28	38			32		22
16		64	26			28		39
17		32	28			25		49
18		24	41			22		39
19	26	20	30			22		32
20	26	19	26			72		25
21	26	18	35			43	39	22
22	22	18	38			22	35	19
23	20	17	26			22	32	19
24	19	17	30			22	28	19
25	18	18	20			19	25	16
26	18	18	18		28	19	25	16
27	18	18	18		25	16	25	16
28	20	17	17		25	16	51	16
29	19	17	17		25	16	35	16
30	18	17	17		28	16	55	16
31	19	17			25		55	

NOTE.—Discharge determined from fairly well defined rating curves applicable as follows: July 19 to Oct. 12, Mar. 26 to May 8, and May 21 to June 30. Gage heights not recorded on days for which discharge is not given.

Digitized by Google

Monthly discharge of Koaie River near Waimea, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July 19–31	26	18	20.7	32.0	269	826
August	64	17	24.1	37.3	749	2,290
September	41	17	23.6	36.5	708	2,170
October 1–12	60	19	27.9	43.2	335	1,030
March 26–31	28	25	26.0	40.2	156	479
April	108	16	29.7	46.0	892	2,730
June	51	16	28.2	43.6	845	2,600

WAIALAE RIVER AT ELEVATION 800 FEET, NEAR WAIMEA, KAUAI.

LOCATION.—Half a mile above confluence with Waimea River and 10 miles north of Waimea.

RECORDS AVAILABLE.—December 31, 1915, to June 30, 1917.

GAGE.—Gurley printing water-gage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight in vicinity of gage; banks steep and high. Control composed of boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 6.55 feet at 10.30 p. m. December 18, 1916 (discharge not determined); minimum stage recorded, 1.1 feet June 27–30 (discharge, 7.5 million gallons per day, or 11.6 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane, rice, and taro, and for power and domestic supply.

ACCURACY.—Records July 1 to October 29 and March 27 to June 30, good for low and medium stages; October 30 to February 20, poor because of insufficient current-meter measurements.

Discharge measurements of Waialae River at elevation 800 feet, near Waimea, Kauai during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 18	D. E. Horner	2.20	26	17
19	do	2.06	14	9.2
Aug. 9	do	1.94	8.9	5.7
Oct. 21	do	2.12	16	11
23	do	2.23	25	16
Mar. 28	W. V. Hardy	1.32	22	14
May 19	D. E. Horner	2.05	93	60
26	do	1.58	38	24

Digitized by Google

Daily discharge, in million gallons, of Waialae River at elevation 800 feet, near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	18	6.0	5.0	6.0	16	88	128	46	.....	114	.....	42
2	16	7.0	5.0	5.0	7.0	54	135	284	.....	26	.....	21
3	9.0	24	5.0	5.0	6.0	21	94	101	.....	17	.....	17
4	34	11	5.0	5.0	30	16	108	88	.....	29	.....	21
5	11	11	5.0	21	54	9.0	65	82	.....	32	.....	29
6	7.0	7.0	4.2	88	9.0	5.0	55	88	.....	26	.....	29
7	7.0	6.0	4.2	50	46	116	35	88	.....	21	.....	50
8	6.0	6.0	6.0	16	58	93	26	82	.....	21	.....	38
9	6.0	6.0	11	9.0	27	78	35	88	.....	19	.....	19
10	6.0	5.0	9.0	7.0	21	68	46	94	.....	17	.....	17
11	6.0	5.0	7.0	7.0	58	50	94	76	.....	12	.....	15
12	6.0	5.0	6.0	21	160	30	65	82	.....	29	.....	13
13	18	6.0	6.0	68	128	30	29	121	.....	26	.....	13
14	24	6.0	5.0	21	88	24	17	65	.....	29	.....	13
15	11	6.0	5.0	16	54	21	15	35	.....	24	.....	13
16	27	6.0	5.0	14	27	18	38	50	.....	17	.....	21
17	24	6.0	5.0	14	11	21	108	65	.....	13	.....	29
18	21	16	5.0	14	63	312	92	164	.....	12	.....	21
19	9.0	9.0	14	16	30	302	204	101	.....	12	.....	19
20	9.0	21	9.0	16	38	121	400	94	.....	50	.....	13
21	9.0	11	6.0	11	104	101	204	.....	.....	32	26	12
22	7.0	11	11	9.0	98	108	135	.....	.....	15	21	10
23	7.0	7.0	6.0	19	83	164	88	.....	.....	13	21	8.8
24	6.0	6.0	5.0	24	54	230	172	.....	.....	12	21	8.8
25	6.0	6.0	11	73	27	142	114	.....	.....	10	17	8.8
26	6.0	5.0	14	18	27	114	101	.....	.....	10	15	8.8
27	5.0	5.0	14	11	21	108	94	.....	12	.....	15	7.5
28	5.0	5.0	9.0	73	24	108	94	.....	12	.....	29	7.5
29	6.0	5.0	7.0	116	27	121	88	.....	12	.....	21	7.5
30	5.0	5.0	6.0	83	122	108	76	.....	13	.....	35	7.5
31	5.0	5.0	.....	42	.....	108	46	.....	.....	.....	.....	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1 to Oct. 29 and Oct. 30 to Dec. 17 well defined below 30 million gallons per day; Dec. 18, 1916, to June 30, 1917, fairly well defined. Gage heights Feb. 21 to Mar. 7 unreliable. No record Mar. 8–26. Gage heights Apr. 27 to May 20 were lost.

Monthly discharge of Waialae River at elevation 800 feet, near Waimea, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	34	5.0	11.0	17.0	342	1,050
August	24	5.0	7.94	12.3	246	755
September	14	4.2	7.18	11.1	215	661
October	116	5.0	29.0	44.9	898	2,760
November	160	6.0	50.6	78.3	1,520	4,660
December	312	5.0	93.2	144	2,890	8,870
January	400	15	96.5	149	2,990	9,180
February 1–20	284	35	94.7	146	1,890	5,810
April 1–26	114	10	24.5	37.9	638	1,950
May 21–30	35	15	22.1	34.2	221	678
June	50	7.5	18.0	27.8	540	1,660

Digitized by Google

KEKAHA DITCH AT FLUME NO. 4, NEAR WAIMEA, KAUAI.

LOCATION.—About a mile below intake, 7 miles, by trail, north of Waimea.
RECORDS AVAILABLE.—February 25, 1916, to June 30, 1917.
GAGE.—Vertical staff at lower end of flume.
DISCHARGE MEASUREMENTS.—Made from cross beam near lower end of flume.
CHANNEL AND CONTROL.—Straight wooden flume 8 feet wide and 4 feet deep.
EXTREMES OF DISCHARGE.—Maximum stage recorded, 3.1 feet frequently (discharge, 62 million gallons per day, or 96 second-feet); water occasionally shut off.
DIVERSIONS.—Ditch diverts from Waimea River.
REGULATION.—By head gates.
UTILIZATION.—Irrigation of sugar cane.
ACCURACY.—Gage read twice daily. Records good above 30 million gallons per day.

Discharge measurements of Kekaha ditch at flume No. 4, near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 18	D. E. Horner	2.97	88	57
Oct. 21	do	2.91	88	57
Mar. 26	W. V. Hardy	2.82	88	57
30	do	2.85	90	58
May 27	D. E. Horner	2.85	89	58

Daily discharge, in million gallons, of Kekaha ditch at flume No. 4, near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	58	42	31	32	35	56	34	46	55	60	60	56
2	58	51	31	31	35	55	34	44	55	60	58	56
3	58	58	30	30	35	55	45	11	56	60	58	32
4	58	58	30	29	35	55	45	.....	58	58	58	56
5	58	58	30	31	45	55	45	.....	60	58	58	56
6	58	48	30	34	56	55	46	.....	60	58	58	56
7	53	45	39	34	58	55	48	39	60	60	58	56
8	50	55	55	50	58	53	48	39	60	60	53	56
9	44	44	50	51	58	53	48	39	62	58	51	56
10	45	35	55	50	58	53	42	39	62	58	50	58
11	48	35	50	40	46	53	37	39	62	58	46	56
12	51	46	51	45	35	53	40	58	62	56	46	56
13	58	58	35	58	60	53	40	58	62	58	46	56
14	60	55	32	46	58	53	14	39	62	58	46	58
15	62	53	31	50	55	53	46	39	62	56	46	58
16	62	58	32	51	58	53	48	51	62	56	50	58
17	62	53	31	53	60	53	48	51	24	60	55	60
18	58	58	32	58	60	30	48	45	24	58	60	56
19	58	58	58	58	58	15	32	50	24	58	58	56
20	58	58	58	58	58	8.0	19	46	14	58	60	56
21	58	58	58	58	35	11	29	50	14	56	60	56
22	50	58	58	53	35	35	40	50	14	56	60	56
23	45	53	58	58	35	35	39	50	14	56	58	56
24	42	45	58	58	46	25	45	50	14	56	60	53
25	39	39	56	58	58	32	40	53	22	56	60	53
26	35	37	58	58	58	35	44	53	40	55	58	50
27	35	35	58	55	58	35	25	56	62	55	58	50
28	39	31	56	58	58	35	46	60	62	60	58	48
29	39	32	48	55	58	35	46	.....	62	60	58	46
30	35	37	39	46	56	35	46	.....	60	60	56	46
31	35	35	.....	55	.....	35	46	.....	62	.....	62	.....

NOTE.—Discharge determined from rating curve well defined above 30 million gallons per day, applicable July 1 to Feb. 3 and Feb. 7 to June 30. Water turned out of ditch Feb. 4–6.

Digitized by Google

Monthly discharge of Kekaha ditch at flume No. 4, near Waimea, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	62	35	50.6	78.3	1,570	4,810
August	58	31	47.9	74.1	1,490	4,560
September	58	30	44.6	69.0	1,340	4,110
October	58	29	48.4	74.9	1,500	4,600
November	60	35	50.6	78.3	1,520	4,660
December	56	8	42.5	65.8	1,320	4,040
January	48	14	40.4	62.5	1,250	3,840
February (25 days)	60	11	46.2	71.5	1,160	3,550
March	62	14	47.5	73.5	1,470	4,520
April	60	55	57.9	89.6	1,740	5,330
May	62	46	55.6	86.0	1,720	5,290
June	60	32	54.1	83.7	1,620	4,980
The year					17,700	54,300

KEKAHA DITCH BELOW TUNNEL NO. 12, NEAR WAIMEA, KAUAI.

LOCATION.—About 7½ miles below intake, 2 miles by trail from Waimea, and half a mile below diversion for Waimea domestic supply.

RECORDS AVAILABLE.—July 20, 1916, to June 30, 1917.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made from plank at gage.

CHANNEL AND CONTROL.—Channel cut in lava rock; fairly straight in vicinity of gage. Control is old wooden weir.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.6 feet December 1 (discharge, 50 million gallons per day, or 77 second-feet); water shut off December 24, 25, and 31.

DIVERSIONS.—Small amount is diverted above station for domestic supply and occasionally for irrigation of rice and taro.

REGULATION.—By head gates.

UTILIZATION.—For irrigation of sugar cane, rice, and taro and for domestic supply.

ACCURACY.—Rating curve is well defined for all stages, but records for the higher stages may be somewhat in error, owing to unrecorded fluctuations in stage, as gage is read but once daily.

Discharge measurements of Kekaha ditch below tunnel No. 12, Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 30	W. V. Hardy	2.27	42	27
Sept. 3	do	2.12	37	24
Oct. 25	D. E. Horner	3.48	69	45
Nov. 5	W. V. Hardy	2.97	59	38
Dec. 2	D. E. Horner	3.54	73	47
Jan. 29	do	3.18	66	43
Feb. 12	do	2.99	61	39
17	do	2.59	51	33
17	do	2.80	56	36
27	do	3.12	64	41
Mar. 6	do	3.34	70	45
23	do	1.18	18	11
Apr. 23	W. V. Hardy	3.03	60	39
May 28	D. E. Horner	2.96	59	38
June 1	do	2.88	57	37

Digitized by Google

Daily discharge, in million gallons, of Kekaha ditch below tunnel No. 12, near Waimea, Kauai, for the year ending June 30, 1912.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	.....	38	31	30	40	50	35	46	43	38	43	37
2	.....	41	29	28	32	48	35	46	43	40	40	33
3	.....	47	29	27	32	46	34	46	44	41	43	23
4	.....	46	28	26	34	45	41	46	43	41	42	35
5	.....	46	28	25	39	43	30	46	44	41	41	37
6	.....	44	28	38	44	43	38	46	45	41	40	43
7	.....	38	27	33	44	42	35	46	45	43	40	41
8	.....	44	44	32	46	46	37	32	43	41	38	42
9	.....	39	44	36	43	46	37	29	43	43	39	38
10	.....	35	46	40	43	46	42	35	45	42	39	40
11	.....	34	36	35	43	44	30	35	42	38	38	40
12	.....	33	46	32	31	43	28	35	42	36	36	39
13	.....	45	45	40	38	42	31	27	43	38	36	39
14	.....	44	32	38	41	41	9.0	29	43	38	38	39
15	.....	44	31	38	40	41	28	29	43	40	37	38
16	.....	46	33	36	43	41	42	28	43	39	38	41
17	.....	41	31	24	41	41	43	28	41	28	40	43
18	.....	46	29	40	44	46	42	28	26	38	38	38
19	.....	45	45	41	42	18	42	29	31	38	46	39
20	28	45	46	42	44	6	36	31	47	40	41	38
21	28	46	46	43	47	27	18	38	14	40	40	37
22	28	43	46	41	47	22	23	38	14	40	41	36
23	38	43	42	40	29	38	31	38	14	40	41	37
24	36	35	45	44	31	.....	46	38	14	42	41	38
25	36	32	45	47	40	.....	39	38	14	44	39	35
26	35	29	43	46	42	14	39	38	43	45	38	34
27	33	29	44	43	42	30	39	35	43	43	38	35
28	34	29	44	43	42	32	39	35	43	41	38	36
29	35	29	32	38	46	35	39	.....	44	40	14	38
30	32	31	32	37	47	28	39	.....	43	39	37	38
31	32	32	.....	40	.....	.....	39	.....	43	.....	36	.....

NOTE.—Discharge determined from well-defined rating curve. No flow Dec. 24, 25, and 31.

Monthly discharge of Kekaha ditch below tunnel No. 12, near Waimea, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July 20–31	38	28	32.9	50.9	395	1,210
August	47	29	39.3	60.8	1,220	3,740
September	46	27	37.6	58.2	1,130	3,460
October	47	24	36.9	57.1	1,140	3,510
November	47	29	40.6	62.8	1,220	3,740
December (28 days)	50	6	37.3	57.7	1,040	3,210
January	46	9	35.0	54.2	1,090	3,330
February	46	27	36.2	56.0	1,020	3,110
March	47	14	37.7	58.3	1,170	3,590
April	45	28	39.9	61.7	1,200	3.670
May	46	14	38.6	59.7	1,200	3,670
June	43	23	37.6	58.2	1,130	3,460
The period	.....	.....	.....	.....	13,000	39,700

Digitized by Google

WAIMEA DITCH NEAR WAIMEA, KAUAI.

LOCATION.—Half a mile below intake, at lower portal of tunnel No. 22, 2½ miles north of Waimea.

RECORDS AVAILABLE.—February 28, 1916, to June 30, 1917.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made from foot plank 10 feet below gage.

CHANNEL AND CONTROL.—Clean channel about 4 feet wide in solid rock. Control, solid rock.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 1.3 feet June 20, 1916 (discharge, 7 million gallons per day, or 11 second-feet); ditch occasionally dry.

DIVERSIONS.—Ditch diverts from Waimea River.

UTILIZATION.—Irrigation of sugar cane and domestic supply.

ACCURACY.—Gage read twice daily. Records good for all stages.

Discharge measurements of Waimea ditch near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 30	W. V. Hardy	0.88	4.6	3.0
Sept. 3	do	.88	5.3	3.4
26	D. E. Horner	1.02	7.2	4.6
27	do	1.22	8.6	5.6
Oct. 15	W. V. Hardy	.42	1.1	.7
Nov. 3	do	.66	3.3	2.1
26	do	1.14	6.8	4.4
Dec. 2	D. E. Horner	.98	6.4	4.1
Jan. 28	do	.72	3.6	2.3
Feb. 12	do	.34	.6	.4
Mar. 10	do	.94	6.1	3.9
Apr. 23	W. V. Hardy	.91	5.3	3.4
May 28	D. E. Horner	1.17	7.8	5.1
June 1	do	.55	2.0	1.3
5	do	1.11	5.96	3.8

Daily discharge, in million gallons, of Waimea ditch near Waimea, Kauai, for the years ending June 30, 1916 and 1917.

Date.	Mar.	Apr.	May.	June.	Date.	Mar.	Apr.	May.	June.
1916.					1916.				
1	.....	3.9	4.3	4.8	16	.....	5.2	3.1	6.1
2	.....	3.5	4.3	5.2	17	.....	4.3	5.2	6.1
3	.....	4.3	5.6	5.2	18	.....	4.3	4.3	4.3
4	.....	4.8	4.3	5.2	19	.....	5.2	4.8	5.2
5	.....	3.9	5.2	5.2	20	2.3	3.5	5.2	7.0
6	.....	3.1	5.2	4.8	21	1.9	3.9	5.2	6.1
7	.....	2.7	3.9	4.8	22	1.2	3.9	5.2	5.2
8	.....	2.7	4.3	5.2	23	2.3	3.1	4.8	5.2
9	.....	2.7	4.3	5.2	24	2.7	2.7	5.2	4.3
10	.....	3.1	5.2	5.2	25	2.7	3.5	4.8	5.2
11	.....	3.1	4.3	5.4	26	2.3	2.7	4 3	6.1
12	.....	3.1	3.9	5.4	27	1.9	3.1	3.9	6.1
13	.....	2.7	3.5	5.6	28	1.9	3.1	4 3	6.1
14	.....	5.2	4.3	5.6	29	3.5	3.1	5.2	6.1
15	.....	5.2	3.5	5.6	30	3.5	3.5	5.2	6.1
					31	3.5	.....	5.0	.....

Digitized by Google

Daily discharge, in million gallons, of Waimea ditch near Waimea, Kauai, for the years ending June 30, 1916 and 1917—Continued.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1916–17.												
1	6.2	3.5	3.5	3.5	4.2	3.5	.....	1.3	0.6	3.8	1.0	1.0
2	6.2	3.5	3.5	3.5	3.8	4.2	.....	.....	.8	3.8	2.2	1.0
3	5.5	5.5	3.5	3.2	1.9	3.2	.....	.....	1.9	4.2	2.9	2.2
4	6.2	4.8	3.2	3.2	2.6	3.8	.....	.....	.....	2.9	2.9	3.8
5	5.5	5.5	3.2	3.5	3.5	4.5	.....	1.6	3.5	2.6	2.9	4.2
6	4.8	4.4	3.2	4.5	4.2	4.2	.....	2.9	4.2	2.9	2.9	4.2
7	4.8	3.2	2.9	3.8	4.2	4.2	.....	2.9	4.2	2.9	2.9	2.9
8	4.2	3.8	4.5	3.5	3.8	2.2	.....	2.6	4.5	2.9	2.9	3.2
9	4.2	3.5	4.2	3.5	3.5	2.2	1.9	2.2	4.8	2.9	2.9	2.6
10	4.2	3.2	5.8	4.8	3.5	2.2	2.2	1.6	4.5	3.5	3.2	.....
11	4.2	3.2	4.2	2.2	3.5	2.9	1.0	1.0	4.2	4.2	3.5	2.9
12	5.2	3.2	4.8	1.6	3.5	3.5	1.6	.6	3.5	2.9	3.5	4.2
13	6.2	4.2	3.8	1.3	2.9	5.2	1.0	.6	3.5	2.9	3.5	4.8
14	4.5	4.8	3.5	.6	3.5	4.8	.....	2.9	3.5	3.2	3.5	4.8
15	4.2	4.2	3.5	1.3	3.8	2.9	.....	.5	4.2	4.8	3.5	4.8
16	4.8	5.5	3.5	1.0	4.2	3.8	.6	.....	1.0	4.8	3.5	5.5
17	4.8	3.8	3.5	3.5	3.5	4.8	.6	.....	2.2	4.2	4.0	5.2
18	4.8	5.8	3.2	4.2	4.2	5.5	.6	.....	2.9	3.2	4.8	4.8
19	4.8	5.5	5.8	4.2	3.8	.....	1.3	.....	.6	3.2	3.5	4.8
20	4.2	5.5	6.2	4.5	3.2	.....	.....	.....	3.5	3.5	3.8	4.8
21	4.8	4.8	5.5	4.2	4.2	.....	.....	.....	.....	2.9	3.5	4.5
22	4.8	4.5	5.2	3.5	3.5	.....	.....	1.0	.....	2.9	2.9	4.5
23	4.2	4.5	5.5	4.2	3.5	.....	.....	.5	.....	3.5	2.9	4.2
24	4.2	3.5	4.8	4.2	3.5	.....	.....	.4	.....	3.5	4.8	4.2
25	4.2	3.5	4.2	5.5	4.5	.....	1.6	.4	.....	3.2	3.5	4.2
26	3.5	3.5	4.8	4.2	4.8	.....	.8	.4	.....	1.6	3.8	4.2
27	3.2	3.5	4.8	3.2	3.8	.....	.4	.6	.....	1.9	3.5	4.2
28	3.8	3.5	3.2	2.9	4.2	.....	1.0	1.6	.....	1.6	4.8	4.2
29	4.2	3.5	3.8	4.5	4.2	.....	2.2	.....	2.6	1.6	4.2	4.2
30	3.5	3.5	3.5	4.8	4.2	.....	1.6	.....	2.2	.6	3.5	4.8
31	3.5	3.5	.....	4.5	.....	.....	1.3	.....	2.2	.....	1.0	.....

NOTE.—Discharge determined from a well-defined rating curve; interpolated July 12, Aug. 1, 6, and 27. No flow on days for which discharge is not given.

Monthly discharge of Waimea ditch near Waimea, Kauai, for the years ending June 30, 1916 and 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
1916.						
March 20–31	3.5	1.2	2.48	3.84	30	91
April	5.2	2.7	3.64	5.63	109	335
May	5.6	3.1	4.57	7.07	142	435
June	7.0	4.3	5.45	8.43	164	502
The period	7.0	1.2	4.31	6.67	445	1,360
1916–17.						
July	6.2	3.2	4.63	7.16	143	440
August	5.8	3.2	4.14	6.41	128	394
September	6.2	2.9	4.16	6.44	125	383
October	5.5	.6	3.45	5.34	107	328
November	4.8	1.9	3.72	5.76	112	342
December (18 days)	5.5	2.2	3.76	5.82	68	208
January (16 days)	2.2	.4	1.23	1.90	20	60
February (19 days)	2.9	.4	1.35	2.09	26	79
March (22 days)	4.8	.6	2.96	4.58	65	200
April	4.8	.6	3.07	4.75	92	283
May	4.8	1.0	3.30	5.11	102	314
June (29 days)	5.5	1.0	3.96	6.13	115	352
The year	.....	.....	.....	.....	1,100	3,380

KAMENEHUNE DITCH NEAR WAIMEA, KAUAI.

LOCATION.—200 feet below wire suspension bridge across Waimea River, about 3 miles above Waimea; reached by wagon road up the right side of Waimea River.

RECORDS AVAILABLE.—October 9, 1911, to June 30, 1917.

GAGE.—Vertical staff on right bank.

DISCHARGE MEASUREMENTS.—Made from plank.

Digitized by Google

CHANNEL AND CONTROL.—Straight for 50 feet above and below gage; mud bottom. Stage-discharge relation affected by growth of grass and weeds in channel; current sluggish.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 1.8 feet at 7.30 a. m. July 4, 1916 (discharge, 5.5 million gallons per day, or 8.5 second-feet); ditch occasionally dry.

DIVERSIONS.—Diverts from Waimea River.

REGULATION.—By head gates.

UTILIZATION.—Irrigation of rice and taro.

ACCURACY.—Gage read twice daily. Record poor, owing to instability of stage-discharge relation due to vegetal growth in channel and frequent cleaning of ditch.

Discharge measurements of Kamenehune ditch near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height. (feet)	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 30	W. V. Hardy	0.80	1.4	0.9
Sept. 26	do	1.11	2.9	1.9
Oct. 3	do	.98	2.3	1.5
25	D. E. Horner	1.44	5.3	3.4
Nov. 29	do	1.16	3.8	2.5
Dec. 1	do	.84	1.8	1.2
29	W. V. Hardy	.90	.7	.45
Jan. 27	D. E. Horner	.86	1.5	.95
29	do	.95	1.4	.85
Feb. 12	W. V. Hardy	.66	.4	.25
Mar. 6	D. E. Horner	1.27	5.3	3.4
Apr. 24	W. V. Hardy	1.10	2.8	1.8

Daily discharge, in million gallons, of Kamenehune ditch near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	4.0	1.6	0.8	2.0	1.2	2.8	0.6	1.0	0.6	1.8	2.5	2.0
2	3.5	1.8	.6	1.6	1.0	2.2	.45	3.5	1.2	1.8	2.2	1.8
3	4.0	2.2	1.2	1.4	1.0	1.8	.1	2.5	1.0	1.6	2.2	1.8
4	4.8	2.2	1.2	1.8	1.6	1.2	.3	2.2	2.8	1.4	1.8	1.6
5	1.6	2.2	1.0	2.2	3.0	1.4	.02	2.0	2.5	1.4	2.2	2.0
6	1.8	1.8	1.0	2.0	2.2	1.0	.3	2.2	2.8	1.2	2.0	2.0
7	2.0	1.6	1.0	1.8	2.5	2.5	.1	1.8	2.8	1.0	2.0	2.0
8	1.8	1.4	1.0	2.2	2.8	2.5	.02	1.4	3.0	1.0	2.0	2.0
9	2.2	1.6	1.4	2.2	2.0	2.8	.45	1.2	2.8	1.8	1.8	2.2
10	2.0	1.4	1.6	2.2	1.2	3.2	2.5	.8	2.2	1.6	2.0	2.2
11	2.0	1.4	1.0	2.0	1.8	2.0	1.8	.8	2.2	2.8	2.0	2.2
12	2.5	1.8	1.4	2.0	1.6	1.6	1.6	.45	2.0	2.5	1.8	2.0
12	3.5	3.0	1.2	2.0	1.2	2.0	1.2	.8	2.8	2.8	2.8	2.2
14	3.5	1.6	1.4	1.8	1.2	2.0	1.2	3.8	2.5	1.8	3.0	2.0
15	3.2	3.0	1.2	1.8	1.6	1.2	.3	3.0	2.8	2.2	3.0	2.0
16	4.2	1.8	1.4	1.6	1.6	.8	1.2	2.5	2.5	2.0	2.8	2.8
17	3.5	1.8	1.4	1.8	1.2	2.0	1.8	2.2	1.8	1.8	2.5	2.8
18	2.5	3.0	1.0	1.8	2.5	4.5	1.4	3.2	2.5	1.2	2.5	2.8
19	1.6	3.2	2.2	1.8	1.6	.....	.8	2.8	2.2	1.2	2.5	2.5
20	2.0	2.2	3.0	2.5	1.4	.....	.....	2.8	3.8	1.0	2.2	1.8
21	2.0	2.0	3.0	2.0	3.0	.....	.....	2.2	2.2	2.0	2.0	2.0
22	2.2	1.6	2.2	1.8	2.0	.8	.....	2.2	1.8	3.0	2.8	1.8
23	2.0	1.2	3.0	2.0	1.6	.6	.....	1.6	1.6	3.0	2.8	1.6
24	1.6	1.2	3.0	2.5	1.2	.3	2.0	1.2	1.4	3.0	2.5	1.6
25	1.2	1.0	2.8	3.8	.8	.15	1.4	1.2	1.4	2.5	2.5	2.2
26	1.4	1.0	2.0	2.2	1.8	.1	.6	1.2	1.4	2.5	2.5	2.8
27	1.2	1.8	2.2	2.0	1.6	.1	.45	1.2	1.4	2.5	2.5	2.8
28	1.2	1.6	2.0	3.8	1.8	.1	1.0	1.4	1.4	2.2	3.0	2.8
29	1.2	.8	1.6	2.8	2.5	.45	1.2	.....	1.6	2.2	3.0	2.5
30	1.2	1.0	1.6	1.4	2.8	.05	1.2	.....	1.6	2.0	2.8	2.5
31	1.2	.8	.....	1.0	.....	.02	.8	.....	1.6	.....	2.2	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1 to Dec. 18 and Jan. 29 to June 30, fairly well defined; Dec. 19 to Jan. 28, poorly defined. No flow on days for which discharge is not given.

Digitized by Google

Monthly discharge of Kamenehune ditch near Waimea, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	4.8	1.2	2.34	3.62	73	223
August	3.2	.8	1.76	2.72	55	167
September	3.0	.6	1.65	2.55	49	152
October	3.8	1.0	2.06	3.19	64	196
November	3.0	.8	1.78	2.75	53	164
December (28 days)	4.5	.02	1.43	2.21	40	123
January (27 days)	2.5	.02	.92	1.42	25	76
February	3.8	.45	1.90	2.94	53	163
March	3.8	.6	2.07	3.20	64	197
April	3.0	1.0	1.96	3.03	59	180
May	3.0	1.8	2.40	3.71	74	228
June	2.8	1.6	2.18	3.37	65	201
The year					674	2,070

MAKAWELI RIVER NEAR WAIMEA, KAUAI.

LOCATION.—Half a mile above confluence with Waimea River and 2 miles northeast of Waimea. Reached by wagon road up Makaweli River.

RECORDS AVAILABLE.—October 6, 1911, to June 30, 1917.

GAGE.—Vertical staff on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 500 feet above and below gage; banks low, with gentle slope; current swift. Control composed of boulders; fairly permanent between extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 13.5 feet December 18,1916 (discharge, approximately 7,500 million gallons per day, or 11,600 second-feet); minimum stage recorded, 3.0 feet December 16–19, 1912 (discharge, 1.9 million gallons per day, or 3.0 second-feet).

DIVERSIONS.—There are many small diversions above station for irrigation of sugar cane, rice, and taro.

REGULATION.—None.

UTILIZATION.—Water passing station is wasted.

ACCURACY.—Rating curves fairly well defined for low and medium stages. Records below 500 million gallons per day, fair; those for high and fluctuating stages probably considerably in error as gage is read only once daily.

Discharge measurements of Makaweli River near Waimea, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 30	W. V. Hardy	3.08	12	7.8
Sept. 25	.....do	3.35	25	16
28	.....do	3.38	38	25
Nov. 15	.....do	4.08	138	89
Dec. 2	D. E. Horner	3.91	121	78
Jan. 28	.....do	3.48	61	40
Mar. 7	.....do	3.78	100	65
Apr. 24	W. V. Hardy	3.56	62	40
May 28	D. E. Horner	3.43	50	33
June 1	.....do	4.08	153	99
5	.....do	4.16	166	107
13	.....do	3.30	39	25

Digitized by Google

Daily discharge, in million gallons, of Makaweli River near Waimea, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	9.2	11	9.2	14	25	116	157	52	39	130	39	82
2	12	99	9.2	12	22	109	139	176	36	39	36	76
3	12	53	22	12	22	122	216	216	25	36	47	47
4	244	44	14	12	850	36	186	109	66	22	43	43
5	19	40	12	12	139	36	148	82	52	28	36	148
6	16	14	12	12	139	32	82	56	52	25	56	123
7	16	14	12	11	200	390	61	61	39	32	56	66
8	16	12	11	148	1,390	116	61	56	47	88	47	47
9	11	12	11	22	328	76	52	71	123	61	39	71
10	11	12	9.2	16	148	61	61	52	66	47	39	61
11	11	9.2	14	16	112	52	47	52	43	39	32	236
12	168	9.2	158	14	105	39	52	47	47	515	32	88
13	75	99	105	12	99	47	52	56	61	116	43	71
14	22	12	98	12	98	66	43	82	315	66	32	61
15	16	12	11	19	90	52	39	56	710	139	28	47
16	105	11	9.2	19	16	32	52	52	365	176	32	66
17	139	12	9.2	12	222	32	166	47	130	61	61	61
18	98	112	32	12	148	4,570	32	226	139	39	620	198
19	28	105	12	16	130	1,575	950	328	66	66	575	95
20	28	28	11	14	352	226	950	266	395	61	290	71
21	25	16	11	14	226	157	123	216	365	39	88	61
22	12	12	139	16	139	123	116	166	216	28	52	52
23	12	12	32	28	123	1,370	139	139	130	39	43	71
24	12	12	19	28	56	665	139	148	102	39	39	56
25	11	12	16	442	36	236	88	139	71	290	32	52
26	11	12	148	233	28	139	166	71	395	88	43	157
27	9.2	11	120	148	25	157	116	47	236	56	130	82
28	16	11	22	1,950	22	196	47	36	166	36	39	61
29	14	11	14	130	22	226	47	.....	82	32	43	55
30	12	11	12	58	22	116	71	.....	52	43	236	42
31	11	9.2	.....	36	.....	95	66	.....	39	.....	236	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1 to Nov. 19, fairly well defined; Nov. 20 to June 11, fairly well defined; and June 12–30, poorly defined.

Monthly discharge of Makaweli River near Waimea, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	244	9.2	38.8	60.0	1,200	3,690
August	112	9.2	26.8	41.5	832	2,550
September	158	9.2	37.5	58	1,120	3,450
October	1,950	11	113	175	3,500	10,800
November	1,380	16	177	274	5,310	16,300
December	4,570	32	363	562	11,200	34,500
January	950	32	150	232	4,660	14,300
February	328	36	111	172	3,100	9,510
March	710	25	151	234	4,670	14,400
April	515	25	82.9	128	2,490	7,630
May	620	28	102	158	3,150	9,700
June	226	43	81.5	126	2,450	7,500
The year	4,570	9.2	120	186	43,700	134,000

OLOKELE DITCH AT TUNNEL NO. 12, NEAR MAKAWELI, KAUAI.

LOCATION.—About 2 miles below intake, 10 miles northeast of Makaweli.

RECORDS AVAILABLE.—July 24, 1904, to June 30, 1917.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made from plank across ditch.

Digitized by Google

CHANNEL AND CONTROL.—Concrete flume of rectangular section; ditch mostly in rock tunnel; straight for 50 feet above and below gage. Control probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.40 feet, June 25, 1916 (discharge, 82 million gallons per day, or 127 second-feet); water sometimes shut off.

DIVERSIONS.—Ditch diverts all low-water flow of Olokele River.

REGULATION.—Flow regulated by head gates.

UTILIZATION.—For irrigation of sugar cane and for domestic supply.

ACCURACY.—Rating curve well defined. Records for low and medium stages good; those of high and fluctuating stages may be considerably in error as gage is read only once daily.

COOPERATION.—Gage-height records furnished by Hawaiian Sugar Co.

Discharge measurements of Olokele ditch at tunnel No. 12, near Makaweli, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Gage height.	
			Second-feet.	Million gallons per day.
July 20	W. V. Hardy	4.00	113	73
Jan. 24	D. E. Horner	1.90	41	26
Feb. 20	do	1.51	28	18
20	do	1.43	26	17
21	do	1.31	22	14
Mar. 12	do	2.69	68	44
May 29	W. V. Hardy	3.08	83	54

Daily discharge, in million gallons, of Olokele ditch at tunnel No. 12, near Makaweli, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	72	54	41	48	41	72	61	17	43	17	46	28
2	68	72	66	41	54	72	61	17	43	46	46	28
3	50	72	43	43	54	72	68	17	43	46	46	28
4	72	52	43	43	72	72	70	17	43	46	46	66
5	54	54	43	43	72	72	70	17	43	46	46	72
6	48	50	41	72	72	59	54	17	43	46	46	72
7	46	54	72	54	72	59	50	17	43	46	46	72
8	43	52	50	46	72	72	68	17	43	46	46	72
9	43	68	72	46	72	57	54	17	43	46	46	68
10	43	48	50	43	72	70	61	17	43	46	66	57
11	50	50	57	43	72	54	61	17	43	46	48	54
12	54	63	46	43	54	19	54	43	43	46	48	54
13	72	54	43	50	46	17	52	43	43	46	46	52
14	72	54	41	52	50	39	50	17	43	46	48	54
15	72	72	41	63	48	39	59	17	43	46	50	68
16	72	50	41	72	50	39	50	17	17	68	66	50
17	72	52	41	57	72	39	61	17	17	68	72	28
18	72	72	48	63	68	39	28	17	17	68	72	28
19	59	52	61	72	41	39	28	17	17	61	46	59
20	72	72	52	72	52	39	24	17	17	52	46	50
21	59	66	57	68	72	28	24	17	17	50	66	46
22	52	54	50	52	72	28	24	17	17	50	54	46
23	50	46	46	63	54	.....	28	17	17	52	57	46
24	46	46	72	68	50	.....	24	43	17	59	52	43
25	43	43	72	72	50	28	24	43	17	54	48	43
26	43	46	61	66	72	28	24	43	17	28	48	41
27	72	46	72	52	63	61	24	43	17	28	50	41
28	59	46	72	72	72	61	46	43	17	28	59	41
29	46	52	63	72	72	61	46	.....	17	28	50	43
30	59	43	50	72	72	61	46	.....	17	48	50	43
31	54	43	.....	61	.....	61	17	.....	17	.....	50	.....

NOTE.—Discharge determined from a well-defined rating curve. Ditch dry Dec. 23 and 24.

Digitized by Google

Monthly discharge of Olokele ditch at tunnel No. 12, near Makaweli, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	72	43	57.7	89.3	1,790	5,490
August	72	43	54.8	84.8	1,700	5,210
September	72	41	53.6	82.9	1,610	4,930
October	72	41	57.5	89.0	1,780	5,470
November	72	41	61.8	95.6	1,860	5,690
December (29 days)	72	17	50.2	77.7	1,460	4,470
January	70	17	45.5	70.4	1,410	4,330
February	43	17	23.5	36.4	658	2,020
March	43	17	29.6	45.8	917	2,820
April	68	17	46.8	72.4	1,400	4,310
May	72	46	51.8	80.1	1,610	4,930
June	72	28	49.8	77.1	1,490	4,580
The year					17,700	54,200

OLOKELE DITCH AT WEIR, NEAR MAKAWELI, KAUAI.

LOCATION.—About 5 miles below intake and 7 miles northeast of Makaweli.

RECORDS AVAILABLE.—January 1, 1912, to June 30, 1917.

GAGE.—Vertical staff showing head on weir.

DISCHARGE MEASUREMENTS.—Made by 12-foot sharp-crested weir, with end contractions; computations checked by current-meter measurements.

CHANNEL AND CONTROL.—Pool at weir.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 26½ inches May 27, 1916 (discharge, 84 million gallons per day, or 130 second-feet); ditch occasionally dry.

DIVERSIONS.—Diverts all low-water flow of Olokele River.

REGULATION.—By head gates.

UTILIZATION.—For irrigation of sugar cane and for domestic supply.

ACCURACY.—Conditions for measurement by weir good. Records for low and medium stages good, but those for high stages may be in error as gage is read only once daily.

COOPERATION.—Gage-height records copied from records of Hawaiian Sugar Co.

Digitized by Google

Daily discharge, in million gallons, of Olokele ditch at weir, near Makaweli, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	60	49	38	43	45	64	45	22	.....	18	43	36
2	62	57	40	42	46	65	49	24	38	25	41	32
3	49	64	51	40	48	64	49	24	38	38	40	26
4	51	56	38	38	51	64	61	18	38	38	38	32
5	58	58	38	37	66	66	56	23	38	38	37	59
6	45	49	37	58	66	59	51	23	38	39	40	57
7	38	45	40	54	65	50	45	20	35	39	41	60
8	38	56	56	45	63	64	42	19	38	43	40	62
9	38	54	47	42	62	58	45	16	37	43	39	60
10	38	48	60	40	63	54	51	.....	42	39	44	57
11	41	45	49	39	60	52	55	23	40	38	46	53
12	41	54	45	39	60	44	50	14	40	46	42	51
13	60	54	40	45	44	43	47	36	40	44	41	49
14	62	52	38	42	45	28	46	26	44	41	44	46
15	62	55	38	58	45	33	44	14	40	44	48	46
16	62	55	36	50	44	36	44	17	36	52	46	51
17	64	45	43	59	45	39	48	16	14	60	53	51
18	64	59	45	59	59	40	33	18	16	56	58	35
19	61	56	58	62	63	45	24	.....	13	54	55	43
20	54	58	58	64	54	39	.....	13	18	49	42	50
21	61	62	48	62	56	.....	.....	.....	14	44	51	44
22	56	56	50	52	66	26	.....	15	17	44	48	41
23	48	45	59	56	52	.....	21	16	14	49	48	41
24	43	41	59	64	55	.....	24	15	16	53	50	39
25	40	39	58	54	49	.....	20	15	20	48	46	39
26	39	45	60	64	64	.....	27	23	20	42	42	38
27	45	40	60	51	63	.....	24	38	19	28	45	37
28	57	51	64	60	60	.....	39	.....	18	24	50	35
29	47	43	59	64	64	.....	38	.....	16	7.5	48	38
30	50	43	47	58	64	.....	41	.....	15	16	47	39
31	49	40	.....	58	.....	47	.....	.....	17	.....	50	.....

NOTE.—No flow on days for which discharge is not given.

Monthly discharge of Olokele ditch at weir, near Makaweli, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	64	38	51.1	79.1	1,580	4,860
August	64	39	50.8	78.6	1,570	4,830
September	64	36	48.6	75.2	1,460	4,470
October	64	37	51.6	79.8	1,600	4,910
November	66	44	56.2	87.0	1,690	5,170
December (22 days)	66	26	49.1	76.0	1,080	3,310
January (27 days)	61	20	41.4	64.1	1,120	3,430
February (24 days)	38	13	20.3	31.4	488	1,500
March (30 days)	44	13	27.6	42.7	829	2,540
April	60	7.5	40.0	61.9	1,200	3,680
May	58	37	45.3	70.1	1,400	4,310
June	62	26	44.9	69.5	1,350	4,130
The year	.....	.....	.....	.....	15,400	47,100

HANAPEPE RIVER AT KOULA, NEAR ELEELE, KAUAI.

LOCATION.—200 feet above ford, half a mile above the siphon at Koula, and 5 miles north of Eleele.

RECORDS AVAILABLE.—August 18, 1910, to December 15, 1916.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

Digitized by Google

CHANNEL AND CONTROL.—One channel at all stages; straight for 200 feet above and 400 feet below gage; banks high and wooded. Control composed of boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage during period of record, December 18, 1916; water-stage recorder and shelter carried away by flood and stage not recorded; minimum stage recorded, 0.95 foot December 30 and 31, 1913 (discharge, 7.1 million gallons per day, or 11 second-feet).

DIVERSIONS.—Hanapepe ditch diverts part of flow above station.

REGULATION.—By diversions.

UTILIZATION.—Flow at low stages is diverted for irrigation of sugar cane, rice, and taro.

ACCURACY.—Records good for all stages.

Discharge measurements of Hanapepe River at Koula, near Eleele, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 9	W. V. Hardy	1.10	26	17
Oct. 20	do	2.22	201	130

Daily discharge, in million gallons, of Hanapepe River at Koula, near Eleele, Kauai, for the year ending June 30, 1917.

Date.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Date.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	144	24	12	21	56	153	16	128	28	12	28	32	.....
2	50	114	14	14	40	114	17	153	40	24	36	56	.....
3	50	80	12	13	36	74	18	100	74	32	56	231	.....
4	128	80	11	12	200	286	19	45	50	32	144	62	.....
5	36	40	11	40	171	86	20	74	80	16	107	50	.....
6	24	21	12	74	100	62	21	74	45	24	56	144	.....
7	18	40	32	24	332	162	22	40	24	100	62	56	.....
8	14	32	13	14	308	74	23	24	18	50	62	36	.....
9	14	32	45	14	242	50	24	18	28	32	171	40	.....
10	16	18	18	13	93	40	25	16	16	62	286	93	.....
11	13	18	21	24	144	28	26	16	16	144	74	114	.....
12	36	21	13	32	86	36	27	50	16	128	80	62	.....
13	80	18	12	18	56	32	28	21	13	136	600	93	.....
14	107	24	12	21	40	24	29	24	14	62	320	93	.....
15	56	100	12	21	36	21	30	32	13	32	162	308	.....
							31	28	12	.....	100	.....	.....

NOTE.—Discharge determined from well-defined rating curve.

Monthly discharge of Hanapepe River at Koula, near Eleele, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	153	13	52.5	81.2	1,630	4,990
August	114	12	37.1	57.4	1,150	3,530
September	144	11	37.9	58.6	1,140	3,490
October	600	12	87.1	135	2,700	8,290
November	332	32	114	176	3,410	10,500
December 1-15	286	21	82.8	128	1,240	3,810
The period	.....	.....	.....	.....	11,300	34,600

Digitized by Google

HANAPEPE DITCH AT KOULA, NEAR ELEELE, KAUAI.

LOCATION.—At the first flume below siphon at Koula, 4 miles below intake and 4 miles north of Eleele.

RECORDS AVAILABLE.—January 1, 1910, to June 30, 1917.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made in flume.

CHANNEL AND CONTROL.—Wooden flume; straight for 20 feet above and below gage; some vegetal growth on bottom and sides of flume. Control fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.14 feet August and November (discharge, 34 million gallons per day, or 53 second-feet); ditch occasionally dry.

Maximum stage recorded during period of record, 4.97 feet November 30, 1913 (discharge, 67 million gallons per day, or 104 second-feet).

DIVERSIONS.—Diverts part of flow of Hanapepe River.

REGULATION.—By head gates.

UTILIZATION.—For domestic supply and irrigation of sugar cane.

ACCURACY.—Discharge ascertained from fairly well defined rating curve. Records fair for low and medium stages; those for high stages probably somewhat in error owing to fluctuation of stage not shown by the one daily gage reading.

Daily discharge, in million gallons, of Hanapepe ditch at Koula near Eleele, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	34	34	30	33	33	34	17	10	28	22	22	18
2	34	34	33	33	33	34	17	16	28	22	22	16
3	33	34	30	32	33	33	34	14	30	22	22	16
4	34	34	30	32	33	33	21	12	29	22	22	31
5	34	34	29	32	33	33	25	15	21	22	22	33
6	33	34	28	33	33	33	22	12	21	22	22	33
7	33	34	34	33	33	33	22	11	21	22	31	33
8	34	34	32	33	33	33	22	12	21	22	32	33
9	32	34	34	32	33	33	22	12	18	22	32	33
10	34	34	32	30	33	33	22	12	18	22	33	33
11	34	34	33	31	33	33	22	.....	18	22	32	33
12	34	34	31	33	33	33	22	22	22	22	32	33
13	34	34	29	33	33	33	7.3	22	22	22	32	33
14	34	34	28	33	33	33	7.3	12	23	22	32	33
15	34	34	27	32	33	33	22	3.0	24	22	33	33
16	34	34	27	33	33	33	22	3.0	2.3	33	33	33
17	34	34	33	33	33	33	22	3.0	2.3	33	33	33
18	34	34	33	33	33	33	14	.....	2.3	33	33	33
19	34	34	33	33	33	.....	13	4.6	2.3	33	33	33
20	34	34	33	33	34	.5	.7	3.4	.....	33	33	33
21	33	34	33	33	34	.7	.7	3.4	.....	33	33	33
22	34	33	33	33	34	.7	10	2.6	.....	33	33	33
23	33	33	33	33	33	.7	10	2.3	1.0	33	33	33
24	34	33	32	33	34	3.0	10	12	.....	33	33	33
25	34	34	33	33	34	6.0	10	.....	.....	17	33	33
26	34	33	33	33	34	22	10	21	1.2	.....	33	33
27	34	33	.....	33	34	16	10	26	2.3	4.2	33	33
28	34	32	9.6	33	34	16	10	28	2.3	4.2	33	33
29	34	33	33	33	34	19	10	.....	2.3	8.2	33	33
30	34	32	33	33	34	16	10	.....	2.3	22	33	32
31	34	31	.....	33	.....	16	10	.....	2.3	.....	18	.....

NOTE.—Discharge determined from fairly well-defined rating curve. No flow on days for which discharge is not given.

Digitized by Google

Monthly discharge of Hanapepe ditch at Koula, near Eleele, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	34	32	33.8	52.3	1,050	3,220
August	34	31	33.6	52.0	1,040	3,200
September (29 days)	34	9.6	30.7	47.5	892	2,730
October	33	30	32.7	60.6	1,010	3,110
November	34	33	33.3	51.5	1,000	3,070
December (30 days)	34	.5	23.8	36.8	713	2,190
January	34	.7	15.4	23.8	477	1,470
February (25 days)	28	2.3	11.8	18.3	294	905
March (26 days)	30	1.0	14.1	21.8	367	1,130
April (29 days)	33	4.2	23.5	36.4	683	2,090
May	33	18	30.1	46.6	934	2,860
June	33	16	31.3	48.4	938	2,880
The year					9,400	28,900

HANAPEPE DITCH AT WEIR, NEAR HANAPEPE, KAUAI.

LOCATION.—About 2½ miles northeast of Hanapepe, below the last siphon across Hanapepe River.

RECORDS AVAILABLE.—January, 1910, to June 30, 1917.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by 12-foot sharp-crested weir with end contractions.

CHANNEL AND CONTROL.—Weir conditions good.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 19 inches December 29–31 (discharge, 50 million gallons per day, or 77 second-feet); ditch frequently dry.

DIVERSIONS.—Ditch diverts from Hanapepe River.

UTILIZATION.—For irrigation of sugar cane and for domestic use.

ACCURACY.—Records fair.

COOPERATION.—Gage-height records copied from records kept by Hawaiian Sugar Co.

40532°—18—WSP 465——4

Digitized by Google

Daily discharge, in million gallons, of Hanapepe ditch at weir near Hanapepe, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	27	27	30	27	29	27	18	.....	.....	.....	18	.....
2	27	27	24	27	26	27	18	.....	20	.....	18	15
3	27	27	23	27	29	27	24	.....	20	18	18	.....
4	27	27	24	27	27	27	27	.....	20	20	18	.....
5	27	28	23	27	29	27	25	.....	20	20	20	27
6	27	27	23	.....	28	29	22	.....	18	20	23	27
7	23	27	24	.....	30	27	21	.....	18	20	23	27
8	27	27	23	27	27	27	21	.....	20	20	23	27
9	27	27	23	27	27	27	22	.....	18	20	23	27
10	27	27	26	27	.....	27	21	.....	18	20	23	27
11	27	27	26	27	27	27	21	.....	18	20	23	27
12	27	27	26	27	29	27	21	.....	18	20	23	30
13	28	27	23	27	.....	27	.....	.....	18	20	23	29
14	29	27	23	.....	29	27	.....	18	18	20	23	29
15	29	27	23	27	29	27	.....	.....	18	20	23	29
16	29	27	21	27	29	27	.....	.....	.....	20	23	29
17	29	27	23	27	29	9	.....	.....	.....	24	23	29
18	27	27	27	27	29	27	.....	.....	.....	24	.....	29
19	27	27	28	27	29	54	.....	.....	.....	.....	29	29
20	27	27	27	.....	29	26	.....	.....	.....	.....	30	29
21	29	27	26	.....	29	.....	.....	.....	.....	24	30	29
22	27	27	26	27	26	.....	.....	.....	.....	24	30	29
23	28	27	.....	23	27	.....	.....	.....	.....	24	30	28
24	28	27	27	27	27	2.1	.....	.....	.....	.....	30	28
25	27	26	27	28	27	.....	.....	.....	.....	.....	28	.....
26	27	.....	.....	28	27	5.5	.....	18	.....	.....	.....	27
27	27	27	.....	27	27	42	.....	18	.....	.....	.....	27
28	29	27	.....	29	27	51	.....	23	.....	.....	.....	27
29	27	27	.....	20	27	52	.....	.....	.....	24	.....	27
30	27	27	.....	27	27	52	.....	.....	.....	34	.....	27
31	27	27	.....	27	.....	52	.....	.....	.....	.....	.....	.....

NOTE.—No flow on days for which discharge is not given.

Monthly discharge of Hanapepe ditch at weir near Hanapepe, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	29	23	27.4	42.4	848	2,610
August (30 days)	28	26	27.0	41.8	810	2,490
September (24 days)	30	21	24.8	38.4	596	1,830
October (26 days)	29	20	26.7	41.3	695	2,130
November (28 days)	30	26	27.9	43.2	782	2,400
December (27 days)	54	2.1	29.9	46.3	807	2,480
January (12 days)	27	18	21.8	33.7	261	803
March (14 days)	20	18	18.7	28.9	262	803
April (21 days)	34	18	21.7	33.6	456	1,400
May (24 days)	30	18	24.0	37.1	575	1,770
June (26 days)	30	15	27.5	42.5	715	2,190
The year	.....	.....	.....	.....	6,810	20,900

SOUTH FORK OF WAILUA RIVER NEAR LIHUE, KAUAI.

LOCATION.—One mile above Waiehu Falls and about 7 miles northeast of Lihue.

RECORDS AVAILABLE.—December 10, 1911, to June 30, 1917.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight for 600 feet above and below station; right bank steep and high; left bank slopes gently. Control composed of gravel and small boulders; somewhat shifting.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 15.1 feet at 6 p. m. December 18, 1916 (discharge, computed from extension of rating curve, approximately 11,000 million gallons per day, or 17,000 second-feet); minimum stage recorded, 3.09 feet February 14 and 15, 1912 (discharge, 2.9 million gallons per day, or 4.5 second-feet).

Minimum stage recorded during year, 2.85 feet September, May, and June (discharge, 26 million gallons per day, or 40 second-feet).

DIVERSIONS.—Several diversions above station for irrigation and power development.

REGULATION.—By diversions above station.

UTILIZATION.—Water going to waste, except a small amount used for irrigation of rice and taro.

ACCURACY.—Discharge ascertained from well-defined rating curve and a continuous gage-height record. Records good for all stages except extreme floods, for which they are fair.

Discharge measurements of South Fork of Wailua River near Lihue, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 22	D. E. Horner	3.42	108	70
Oct. 24	W. V. Hardy	4.46	419	271
Nov. 3	do	3.75	192	124
5	do	4.11	304	197
Dec. 22	D. E. Horner	4.02	268	173
24	do	6.25	1,300	840
Jan. 20	do	5.25	687	444
Feb. 9	do	3.30	104	67
Mar. 8	do	2.99	54	35
29	do	3.64	161	104
Apr. 5	W. V. Hardy	3.32	118	76
June 29	D. E. Horner	2.90	47	30

Daily discharge, in million gallons, of South Fork of Wailua River near Lihue, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	242	50	37	88	172	396	182	76	50	136	.....	.....
2	136	110	41	76	136	320	192	454	50	102	.....	136
3	110	110	33	65	127	263	344	136	50	102	.....	154
4	222	145	29	60	320	584	263	127	50	76	.....	136
5	102	88	26	102	252	308	296	182	50	70	.....	110
6	82	65	26	172	163	285	172	118	41	60	37	202
7	76	95	41	88	469	788	136	88	60	55	37	584
8	65	88	33	76	516	296	127	76	45	55	37	296
9	65	88	55	76	439	232	110	65	320	65	33	344
10	65	60	37	76	222	232	110	65	76	55	37	192
11	65	55	37	76	344	192	102	60	76	60	26	154
12	88	55	33	82	222	202	88	55	136	136	26	127
13	163	50	26	70	172	212	82	82	252	182	26	102
14	212	55	26	76	182	182	76	76	396	70	29	82
15	118	202	26	76	172	163	76	60	1,620	136	26	118
16	154	76	26	76	145	202	212	55	469	136	41	182
17	242	70	41	95	172	202	454	50	344	65	60	454
18	202	95	55	182	636	1,850	192	192	232	55	212	136
19	95	102	45	296	252	1,540	424	102	252	50	.....	102
20	127	110	37	202	222	956	332	65	1,380	41	.....	82
21	118	88	45	136	584	904	154	65	726	37	.....	41
22	76	65	136	136	252	904	127	60	344	88	.....	37
23	60	55	88	145	192	618	145	60	252	110	.....	41
24	50	70	70	296	182	533	212	60	.....	65	.....	41
25	45	60	127	516	274	192	127	60	.....	136	.....	37
26	50	55	396	182	320	136	102	60	.....	88	.....	33
27	88	55	285	172	212	163	95	60	.....	76	.....	33
28	60	50	242	550	296	202	102	55	.....	65	.....	33
29	55	50	192	601	567	454	102	.....	.....	55	.....	29
30	65	41	118	308	726	252	88	.....	102	202	.....	26
31	60	37	.....	232	.....	192	76	.....	95	.....	.....	.....

NOTE.—Discharge determined from well-defined rating curve. Gage-height record unreliable on days for which discharge is not given.

Digitized by Google

Monthly discharge of South Fork of Wailua River near Lihue, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	242	45	108	167	3,360	10,300
August	202	37	77.3	120	2,400	7,350
September	396	26	80.3	124	2,410	7,390
October	601	60	174	269	5,380	16,600
November	726	127	298	461	8,940	27,400
December	1,850	136	450	696	14,000	42,800
January	454	76	171	265	5,300	16,300
February	454	50	95.1	147	2,660	8,170
April	202	37	87.6	136	2,630	8,070
May 6–18	212	26	48.2	74.6	627	1,920
June 2–30	584	26	139	215	4,040	12,400

HANAMAULU DITCH NEAR LIHUE, KAUAI.

LOCATION.—In flume 180 feet below point where Kauai Electric Co.'s power line crosses the South Fork of Wailua River, about 6 miles northwest of Lihue.

RECORDS AVAILABLE.—July 1, 1910, to June 30, 1917.

GAGE.—Vertical staff. New datum September 30, 1911.

DISCHARGE MEASUREMENTS.—Made in flume.

CHANNEL AND CONTROL.—Wooden flume; straight for 20 feet above and below gage. Control is rock section at end of flume; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.56 feet at 1.15 p. m. July 17 (discharge, 27 million gallons per day, or 42 second-feet).

1910–1917: Maximum stage recorded, 2.80 feet August 6, 1913 (discharge, 36 million gallons per day, or 56 second-feet); ditch occasionally dry.

DIVERSIONS.—Ditch diverts part of flow of South Fork of Wailua River.

REGULATION.—By head gates.

UTILIZATION.—For irrigation of sugar cane and for domestic supply.

ACCURACY.—Gage read once daily. Records fair for all stages.

Discharge measurements of Hanamaulu ditch near Lihue, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 21	D. E. Horner	2.40	36	24
Aug. 23	do	2.39	30	19
Oct. 29	W. V. Hardy	1.29	14	8.8
Nov. 19	do	1.02	8.5	5.5
22	do	.78	6.3	4.0
Dec. 19	D. E. Horner	.55	3.4	2.2
21	do	.62	4.6	3.0
Jan. 18	do	2.00	28	18
Feb. 6	do	.86	5.5	3.6
6	do	1.24	10.3	6.7
8	do	.92	7.4	4.8
8	do	1.56	19	12
Mar. 27	do	.48	2.7	1.8
Apr. 3	W. V. Hardy	2.04	27	17

Digitized by Google

Daily discharge, in million gallons, of Hanamaulu ditch near Lihue, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	23	24	23	23	6.1	5.6	2.9	5.6	18	4.8	19	12
2	22	26	24	23	11	4.4	2.6	7.1	18	4.8	17	9.4
3	22	25	23	22	11	4.0	4.0	4.8	18	17	15	9.4
4	24	26	23	22	12	5.2	6.1	4.8	18	16	14	9.4
5	23	25	24	22	11	4.8	8.8	5.6	18	16	21	9.4
6	22	24	24	23	11	4.8	5.6	5.2	18	18	20	9.4
7	24	24	25	22	13	4.4	5.2	6.1	19	18	20	9.4
8	23	25	24	22	12	4.0	5.2	5.2	18	18	19	2.3
9	23	25	24	22	14	3.6	5.2	12	24	18	18	10
10	23	24	24	22	12	3.6	5.2	12	15	18	20	11
11	22	24	24	22	11	3.6	4.8	12	15	18	18	10
12	23	24	23	24	11	4.8	4.8	11	14	21	17	10
13	24	24	22	23	10	4.8	4.8	11	15	21	17	17
14	24	24	22	23	10	4.4	4.8	3.6	15	16	17	16
15	23	26	22	23	10	4.4	4.8	3.6	26	19	18	17
16	24	26	22	23	4.4	4.4	6.1	14	2.0	21	17	17
17	26	26	24	23	5.6	4.4	7.6	14	1.4	21	19	16
18	24	25	24	24	7.6	5.2	5.6	14	1.2	18	23	17
19	23	26	24	25	5.6	2.3	5.6	6.6	6.1	18	14	16
20	24	26	23	25	4.8	1.4	5.6	6.6	10	18	14	16
21	24	25	23	24	4.8	4.0	5.6	6.6	5.6	21	13	15
22	23	24	24	24	4.0	5.6	5.6	6.1	3.2	21	12	14
23	24	24	25	24	4.0	5.6	5.6	6.1	2.9	21	12	18
24	25	24	24	24	4.0	4.8	5.2	5.6	2.6	18	12	17
25	25	23	23	26	4.0	3.2	4.4	5.6	2.0	24	12	17
26	25	24	26	24	4.4	3.2	4.4	5.6	2.3	21	12	17
27	25	24	26	14	4.0	3.2	4.0	5.6	2.0	13	12	17
28	25	24	26	14	4.4	3.2	4.0	18	1.7	12	12	17
29	24	24	24	10	4.4	3.2	4.4	.....	1.7	12	12	17
30	25	24	23	7.6	6.1	3.2	4.0	.....	5.6	20	13	17
31	26	24	.....	6.6	.....	3.2	4.0	.....	5.6	.....	12	.....

NOTE:—Discharge determined from fairly well defined rating curves.

Monthly discharge of Hanamaulu ditch near Lihue, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	26	22	23.8	36.8	737	2,260
August	26	23	24.6	38.1	763	2,340
September	26	22	23.7	36.7	712	2,180
October	26	6.6	21.2	32.8	656	2,020
November	14	4.0	7.91	12.2	237	728
December	5.6	1.4	4.08	6.31	126	388
January	8.8	2.6	5.05	7.81	156	480
February	18	3.6	8.00	12.4	224	687
March	26	1.2	10.5	16.2	325	999
April	24	4.8	17.8	27.5	534	1,640
May	23	12	15.8	24.4	491	1,500
June	18	2.3	13.7	21.2	412	1,260
The year	26	1.2	14.7	22.7	5,370	16,480

LIHUE DITCH NEAR LIHUE, KAUAI.

LOCATION.—At point where Kauai Electric Co.'s power line crosses ditch, 1½ miles below intake and about 5 miles northwest of Lihue.

RECORDS AVAILABLE.—July 1, 1910, to April 30, 1917, when station was discontinued.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by wading.

Digitized by Google

CHANNEL AND CONTROL.—Channel cut in clay and gravel; ditch clean with low grade. Stage-discharge relation sometimes affected by backwater caused by inflow of Kanaha ditch 260 feet below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 1.6 feet April, May, and June, 1916 (discharge, 14 million gallons per day, or 22 second-feet); ditch occasionally dry.

DIVERSIONS.—Part of flow diverted above station into ditch at lower level.

REGULATION.—By head gates.

UTILIZATION.—Irrigation of sugar cane and for domestic supply.

ACCURACY.—Gage read once daily. Rating curve well defined. Records fair for all stages.

Discharge measurements of Lihue ditch near Lihue, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second feet.	Million gallons per day.
July 21	D. E. Horner	1.38	11.1	7.2
Aug. 4	W. V. Hardy	1.51	12.5	8.1
23	D. E. Horner	1.50	11.7	7.6
Oct. 13	W. V. Hardy	1.40	12.0	7.8
Nov. 19	do	.80	3.4	2.2
19	do	.86	3.8	2.5
Dec. 21	D. E. Horner	.59	1.1	.7
Jan. 17	do	.45	.6	.4

Daily discharge, in million gallons, of Lihue ditch near Lihue, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.
1	8.9	7.2	8.4	8.4	7.8	4.0	.....	.....	.....
2	8.4	7.8	8.4	8.4	7.8	4.0	.....	.....	.....
3	8.4	7.8	8.4	8.4	7.8	3.6	.....	1.2	1.0
4	9.4	8.4	8.4	7.8	6.7	4.0	.....	1.0	6.2
5	8.9	8.4	8.4	7.8	3.6	4.0	.....	1.2	5.7
6	8.4	8.4	8.4	7.8	4.0	3.6	.....	5.7	5.7
7	8.4	8.4	8.9	7.2	4.4	4.0	.....	6.7	5.2
8	8.4	8.4	8.4	6.2	4.0	3.6	.....	7.2	5.2
9	8.4	8.4	8.4	6.2	3.6	3.6	.....	8.4	5.2
10	8.4	8.4	8.9	7.8	3.2	3.6	.....	7.2	7.2
11	8.4	8.4	8.4	8.4	3.2	3.6	.....	7.8	7.2
12	8.4	8.4	8.4	8.4	2.8	3.6	.....	7.8	7.8
13	8.9	7.8	7.8	7.8	2.8	3.6	.....	8.4	7.8
14	8.4	7.8	7.8	7.8	2.8	3.2	.....	8.4	7.2
15	8.4	8.9	7.8	7.8	2.8	3.2	.....	11.6	8.4
16	8.9	8.4	7.2	7.8	2.8	3.2	.....	.....	8.4
17	9.4	7.8	8.4	7.8	2.4	3.2	0.4	.....	7.8
18	8.9	8.4	8.4	7.8	2.8	3.2	.6	.....	7.8
19	7.2	7.8	8.4	7.8	2.4	2.4	.6	.....	7.8
20	7.2	7.8	7.8	7.8	2.4	.8	.6	.....	7.2
21	7.2	7.2	8.4	7.2	2.4	1.0	.4	.....	8.4
22	6.7	7.2	8.4	7.2	2.0	1.0	.2	.....	8.4
23	8.4	8.4	8.9	7.2	4.0	.8	.2	.....	8.4
24	8.4	8.4	8.4	7.2	4.0	1.4	.....	.....	8.4
25	8.4	7.8	7.8	8.4	3.6	1.0	.....	.....	8.4
26	8.4	8.4	8.4	8.4	4.0	.8	.....	.....	7.7
27	7.8	8.4	8.9	8.4	3.6	.8	.....	.....	7.7
28	8.4	8.4	6.7	8.4	4.0	.8	.....	.....	7.7
29	7.8	8.4	6.2	7.8	4.0	.8	.....	.....	7.2
30	7.8	8.4	6.2	.....	4.4	.8	.....	.....	8.4
31	7.8	8.4	.....	.....	.....	.....	.....	.....	.....

NOTE.—Discharge determined from well-defined rating curve. No flow on days for which discharge is not given.

Digitized by Google

Monthly discharge of Lihue ditch near Lihue, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	9.4	6.7	8.30	12.8	257	790
August	8.9	7.2	8.15	12.6	252	775
September	8.9	6.2	8.12	12.6	244	748
October (29 days)	8.4	6.2	7.77	12.0	225	692
November	7.8	2.0	3.87	5.99	116	356
December (30 days)	4.0	.8	2.57	3.98	77	237
January (7 days)	.6	.2	.43	.67	3	9
March (13 days)	11.6	1.0	6.35	9.82	83	253
April (28 days)	8.4	1.0	7.12	11.0	200	612
The period					1,460	4,470

NOTE.—See footnote to daily-discharge table.

NORTH FORK OF WAILUA RIVER AT ELEVATION 650 FEET, NEAR LIHUE, KAUAI.

LOCATION.—One mile above intake of Kanaha ditch and 10 miles northwest of Lihue.

RECORDS AVAILABLE.—September 21, 1914, to June 30, 1917. For old station at elevation 500 feet, December 28, 1910, to September 25, 1914.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight for 80 feet above and 50 feet below gage; right bank steep and high; left bank slopes gently. Control composed of boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.45 feet at 11.45 p. m. December 18 (discharge, approximately 1,600 million gallons per day, or 2,480 second-feet); minimum stage recorded, 1.35 feet September 14–16 (discharge, 19 million gallons per day, or 29 second-feet).

Maximum stage recorded during period of record, 9.5 feet at 6.30 p. m. September 26, 1914 (discharge, computed from extension of rating curve, approximately 2,200 million gallons per day, or 3,400 second-feet); minimum stage recorded, 1.3 feet April, 1916 (discharge, 13 million gallons per day, or 20 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Part of flow is diverted for irrigation of sugar cane but most of it is wasted.

ACCURACY.—Determinations based on well-defined rating curves and a continuous record of gage height. Records good for all stages.

Discharge measurements of North Fork of Wailua River at elevation 650 feet, near Lihue, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 19	D. E. Horner	2.05	96	62
20	do	1.90	73	47
21	do	1.80	62	40
24	do	1.58	40	26
Sept. 24	W. V. Hardy	2.00	94	61
Oct. 13	do	1.62	57	37
Nov. 6	do	1.48	45	29
7	do	2.04	103	67
Dec. 19	D. E. Horner	2.55	198	128
19	do	2.49	182	118
20	do	2.13	115	74
Jan. 19	do	4.10	707	457
Mar. 27	do	2.22	135	87
Apr. 4	W. V. Hardy	1.52	42	27
June 27	D. E. Horner	1.47	46	30

Digitized by Google

Daily discharge, in million gallons, of North Fork of Wailua River at elevation of 650 feet near Lihue, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	94	35	23	49	.....	.....	82	38	25	64	106	.....
2	56	68	28	38	.....	.....	72	106	25	46	49	.....
3	60	64	23	38	.....	.....	113	42	25	56	38	.....
4	88	88	21	35	.....	.....	82	38	32	42	60	.....
5	49	56	21	49	.....	.....	113	38	30	38	32	.....
6	42	42	21	52	.....	72	60	35	32	35	30	.....
7	38	60	30	38	77	166	49	32	49	32	28	.....
8	38	49	21	32	94	77	46	32	32	32	28	.....
9	35	46	38	32	49	68	42	32	100	38	28	.....
10	35	35	25	35	38	77	42	32	52	32	35	.....
11	35	32	23	30	.....	52	38	30	56	46	28	.....
12	49	32	21	35	.....	64	35	30	88	68	28	.....
13	60	30	21	38	.....	64	32	46	150	113	25	.....
14	64	35	19	35	.....	52	30	35	248	64	28	.....
15	49	68	19	35	.....	49	30	30	436	88	25	.....
16	56	35	19	42	.....	52	94	30	228	64	32	.....
17	106	46	25	.....	.....	64	191	28	128	46	46	.....
18	100	46	32	.....	.....	319	68	77	77	42	135	.....
19	56	46	32	.....	.....	158	282	38	100	35	182	.....
20	82	49	25	.....	.....	77	120	32	358	32	.....	.....
21	68	38	28	.....	.....	64	64	30	182	30	.....	.....
22	46	32	60	.....	.....	64	52	28	100	52	.....	.....
23	38	30	49	.....	.....	174	94	28	72	60	.....	.....
24	35	30	46	.....	.....	191	100	28	82	35	.....	.....
25	35	28	52	.....	.....	72	56	28	100	46	.....	.....
26	35	30	113	.....	.....	60	49	25	200	32	.....	.....
27	56	30	106	.....	.....	52	42	25	100	30	.....	30
28	38	28	100	.....	.....	68	46	25	64	30	.....	30
29	42	25	88	.....	.....	142	38	.....	52	28	.....	28
30	42	25	60	.....	.....	82	35	.....	49	113	.....	28
31	38	23	.....	.....	.....	64	32	.....	46	.....	.....	.....

NOTE.—Discharge determined from well-defined rating curves applicable July 1 to Sept. 28 and Sept. 29 to June 30. No record on days for which discharge is not given.

Monthly discharge of North Fork of Wailua River at elevation 650 feet near Lihue, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	106	35	53.7	83.1	1,660	5,110
August	88	23	41.3	63.9	1,280	3,930
September	113	19	39.6	61.3	1,190	3,650
October 1–16	52	30	38.3	59.3	613	1,880
December 6–31	319	49	94.0	145	2,440	7,500
January	282	30	71.9	111	2,230	6,840
February	106	25	36.4	56.3	1,020	3,130
March	436	25	107	166	3,320	10,200
April	113	28	49.0	75.8	1,470	4,510
May 1–19	182	25	50.7	78.4	963	2,960

KANAHA DITCH NEAR LIHUE, KAUAI.

LOCATION.—500 feet above point where Kauai Electric Co.'s power line crosses ditch, and about 9 miles north of Lihue.

RECORDS AVAILABLE.—August 6, 1910, to June 30, 1917.

GAGE.—Vertical staff. New datum May 28, 1913.

DISCHARGE MEASUREMENTS.—Made in flume 100 feet above gage.

Digitized by Google

CHANNEL AND CONTROL.—Cut in soft lava rock; straight for 30 feet above and 10 feet below gage. Control composed of soft lava rock; fairly permanent between times of cleaning ditch.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.45 feet at 11 a. m., September 27 (discharge, 18 million gallons per day, or 28 second-feet); no flow March 17–25.

Maximum stage recorded during period of record, 2.6 feet July 24–26, 1913 (discharge, 22 million gallons per day, or 34 second-feet).

DIVERSIONS.—Ditch diverts part of flow of North Fork of Wailua River.

REGULATION.—By head gates.

UTILIZATION.—For irrigation of sugar cane and for domestic supply.

ACCURACY.—Records based on well-defined rating curves; good for low and medium stages; those for high and fluctuating stages may be somewhat in error as gage is read only once daily.

Discharge measurements of Kanaha ditch near Lihue, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons. per day.
Nov. 7	W. V. Hardy	0.71	8.1	5.2
Dec. 20	D. E. Horner	.80	8.2	5.3
Feb. 7	do	.47	3.8	2.4
7	do	.66	7.0	4.5
7	do	.98	10	6.5
Mar. 28	do	.50	4.2	2.7
June 27	do	1.78	23	15

Daily discharge, in million gallons, of Kanaha ditch near Lihue, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	15	14	13	13	10	6.7	4.2	4.6	7.0	7.0	17	15
2	15	16	16	13	9.8	6.4	4.2	6.7	11	7.8	13	14
3	14	15	14	16	9.8	6.4	4.2	5.6	11	8.8	12	15
4	16	16	14	16	10	6.7	3.9	5.6	11	7.4	16	14
5	14	15	14	16	8.8	6.4	6.0	3.9	11	7.0	14	14
6	15	15	13	15	8.8	6.4	5.3	3.2	13	6.7	13	14
7	14	14	16	15	9.2	8.8	5.0	6.7	15	6.7	13	15
8	14	14	14	15	8.4	6.7	5.0	6.4	13	6.7	13	16
9	14	14	16	15	7.4	6.4	4.6	6.0	14	6.4	12	15
10	14	14	16	15	7.4	6.4	4.6	5.6	14	12	15	16
11	13	13	15	15	7.0	6.0	4.6	5.3	14	13	13	15
12	15	15	15	15	7.4	6.0	4.6	5.0	14	15	12	15
13	16	14	14	15	7.4	7.0	4.6	4.6	14	16	12	13
14	16	13	14	14	7.4	6.0	4.6	4.6	15	14	12	16
15	15	16	14	16	7.4	6.0	6.7	4.2	7.8	16	14	16
16	16	16	14	16	7.4	6.0	8.4	3.9	3.6	15	13	17
17	16	15	17	16	7.4	5.6	7.4	6.0	.....	14	16	16
18	14	15	16	16	8.8	6.7	6.0	6.7	.....	13	16	15
19	14	15	17	16	7.4	5.3	6.4	6.7	.....	13	16	16
20	15	16	16	16	7.0	5.3	6.0	6.4	.....	12	14	16
21	15	15	15	16	6.7	5.3	6.0	5.6	.....	14	15	15
22	13	14	16	16	6.0	5.3	5.6	5.0	.....	16	15	14
23	13	14	17	15	6.0	5.3	6.7	4.2	.....	16	15	16
24	15	14	16	16	5.6	8.1	6.0	3.9	.....	15	14	16
25	14	14	15	17	6.0	5.6	5.6	3.9	.....	16	14	15
26	15	14	15	14	6.0	4.6	5.6	7.4	1.8	15	14	15
27	16	14	18	15	5.6	4.6	5.6	7.4	3.9	14	15	14
28	15	13	17	17	6.0	4.6	5.3	6.7	6.0	14	15	14
29	15	14	16	14	5.6	4.6	5.3	.....	4.6	14	14	14
30	14	13	15	13	6.7	5.0	5.3	.....	4.2	14	16	14
31	14	13	.....	10	.....	4.6	5.0	.....	7.4	.....	15	.....

NOTE.—Daily discharge determined from well-defined rating curves applicable July 1 to June 7 and June 8–30. No flow Mar. 17–25.

Digitized by Google

Monthly discharge of Kanaha ditch near Lihue, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	16	13	14.6	22.6	454	1,390
August	16	13	14.4	22.3	447	1,370
September	18	13	15.3	23.7	458	1,410
October	17	10	15.1	23.4	467	1,440
November	10	5.6	7.48	11.6	224	689
December	8.8	4.6	5.96	9.22	185	567
January	8.4	3.9	5.43	8.40	168	517
February	7.4	3.2	5.42	8.39	152	466
March (22 days)	15	1.8	9.83	15.2	216	664
April	16	6.4	12.2	18.9	366	1,120
May	17	12	14.1	21.8	438	1,340
June	17	13	15.0	23.2	450	1,380
The period					4,030	12,400

NOTE.—See footnote to daily-discharge table.

EAST BRANCH OF NORTH FORK OF WAILUA RIVER NEAR LIHUE, KAUAI.

LOCATION.—400 feet above confluence with North Fork, 600 feet above gaging station on North Fork, and about 8 miles north of Lihue.

RECORDS AVAILABLE.—July 27, 1912, to June 30, 1917.

GAGE.—Stevens water-stage recorder December 31, 1914, to June 30, 1917; staff 250 feet below present site July 27, 1912, to September 30, 1914.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight for 30 feet above and 120 feet below gage; banks low and wooded. Control composed of boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 8.9 feet at 8 a. m. March 3, 1916 (discharge, approximately 3,000 million gallons per day, or 4,640 second-feet); minimum stage recorded, 1.6 feet March, 1915 (discharge, 7 million gallons per day, or 11 second-feet).

Maximum stage recorded during year, 6.85 feet, December 18 (discharge, approximately 1,700 million gallons per day, or 2,630 second-feet); minimum stage recorded, 1.75 feet October 4 (discharge, 8.5 million gallons per day, or 13 second-feet).

DIVERSIONS.—None.

REGULATION.—None.

UTILIZATION.—After joining North Fork of Wailua River part of the water is diverted for irrigation of sugar cane, but most of it is wasted.

ACCURACY.—Records based on well-defined rating curve; good for all stages.

Discharge measurements of East Branch of North Fork of Wailua River near Lihue, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet.)	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 16	D. E. Horner	2.00	30	20
18	do	2.10	40	26
24	do	1.96	26	17
Sept. 4	W. V. Hardy	1.87	20	13
24	do	2.82	187	121
Oct. 13	do	2.00	31	20
Nov. 7	do	2.55	108	70
8	do	2.39	82	53
Dec. 20	D. E. Horner	2.44	97	62
21	do	2.32	62	40
22	do	2.24	59	38
Jan. 18	do	2.28	69	45
June 27	do	2.02	36	23

Digitized by Google

Daily discharge, in million gallons, of East Branch of North Fork of Wailua River near Lihue, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	54	.....	10	12	.....	48	.....	.....	43	20	26
2	30	.....	12	10	.....	60	.....	.....	43	20	26
3	38	.....	12	10	.....	90	.....	.....	54	20	26
4	43	.....	12	8.5	.....	74	.....	.....	38	23	26
5	30	.....	12	10	43	54	.....	.....	30	23	23
6	23	.....	12	15	.....	43	.....	.....	26	23	66
7	23	.....	12	12	.....	38	20	.....	26	23	43
8	20	.....	15	12	82	34	20	.....	26	23	30
9	20	.....	15	12	140	34	20	.....	23	23	26
10	20	.....	18	10	66	34	20	38	26	23	26
11	20	.....	15	10	48	34	20	.....	23	26	23
12	26	.....	12	10	60	26	18	.....	23	26	23
13	34	.....	12	12	38	23	18	.....	26	23	20
14	43	.....	12	.....	34	23	23	.....	26	23	18
15	26	.....	12	.....	38	23	18	.....	30	23	20
16	26	.....	18	.....	38	66	18	.....	23	30	26
17	66	23	20	.....	30	129	15	.....	20	34	26
18	54	23	20	.....	140	54	.....	.....	23	60	26
19	34	30	43	.....	300	129	.....	.....	30	34	23
20	38	30	18	.....	54	118	.....	.....	20	26	23
21	48	30	15	.....	48	54	.....	.....	26	26	23
22	30	23	26	.....	151	43	.....	.....	20	23	23
23	26	20	23	.....	60	34	.....	.....	20	20	23
24	20	18	26	.....	48	90	.....	.....	23	20	26
25	20	20	20	.....	43	43	.....	.....	34	20	23
26	18	20	30	.....	38	38	.....	.....	30	18	.....
26	20	20	20	.....	140	38	.....	.....	23	18	23
28	20	20	20	.....	151	.....	.....	.....	23	18	23
29	.....	20	20	.....	82	.....	.....	38	20	18	20
30	.....	18	12	.....	60	.....	.....	34	20	23	20
31	.....	18	.....	.....	54	.....	.....	34	.....	26	.....

NOTE.—Discharge determined from rating curve well defined below 150 million gallons per day. No record on days for which discharge is not given.

Monthly discharge of East Branch of North Fork of Wailua River near Lihue, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July 1-28	66	18	31.1	48.1	870	2,670
August 17-31	30	18	22.2	34.3	333	1,020
September	43	10	17.5	27.1	524	1,610
October 1-13	15	8.5	11.0	17.0	144	439
January 1-27	129	23	54.6	84.5	1,470	4,520
February 7-17	23	15	19.1	29.6	210	645
April	54	20	27.3	42.2	818	2,510
May	60	18	24.4	37.7	756	2,320

KAPAA RIVER NEAR KEALIA, KAUAI.

LOCATION.—A quarter of a mile below confluence of two main branches, 1½ miles above intake of Kapahi ditch and 6 miles northwest of Kealia.

RECORDS AVAILABLE.—June 23, 1915, to June 30, 1917. July 23, 1910, to May 16, 1915, at old station about a mile downstream.

GAGE.—Friez water-stage recorder; July 23, 1910, to May 16, 1915, vertical staff about a mile below present site.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below gage; right bank vertical; left bank high with gentle slopes. Control fairly permanent between extreme floods.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded at present site, 9.2 feet at 1 a. m. March 4, 1916 (discharge, approximately 850 million gallons per day, or 1,320 second-feet); minimum stage recorded, 1.65 feet August 28 and 29, 1915 (discharge, 11 million gallons per day, or 17 second-feet).

Maximum stage recorded during year, 8.75 feet at 12.15 a. m. March 20 (discharge approximately 800 million gallons per day, or 1,240 second-feet); minimum stage recorded, 1.7 feet September and March (discharge, 12 million gallons per day, or 18.6 second-feet).

Maximum stage recorded during period of record at old staff gage site, 13 feet, ascertained from flood marks, December 3, 1914 (discharge, roughly estimated by extension of previous rating curve, 1,200 million gallons per day, or 1,860 second-feet); minimum stage recorded, 1.35 feet February, March, and April, 1914 (discharge, 6.2 million gallons per day, or 9.6 second-feet).

DIVERSIONS.—Very small irrigation ditch diverts water above station.

REGULATION.—Practically none.

UTILIZATION.—For irrigation of sugar cane and for domestic supply.

ACCURACY.—Records fair for entire year.

Discharge measurements of Kapaa River near Kealia, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 3	W. V. Hardy	2.07	31	20
Nov. 25	do	2.85	110	71
Dec. 28	D. E. Horner	3.13	149	96

Daily discharge, in million gallons, of Kapaa River near Kealia, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	78	17	12	17	16	48	18	20	13	44	28	34
2	24	31	16	16	18	37	20	31	12	31	22	28
3	37	22	12	14	18	31	40	17	12	52	20	31
4	28	37	12	14	40	48	24	16	20	26	18	28
5	17	20	12	18	26	52	34	14	17	24	18	37
6	16	17	12	17	22	56	20	14	22	22	17	48
7	14	26	14	14	48	112	17	13	28	22	17	78
8	14	20	13	16	65	37	16	13	17	20	17	44
9	14	18	13	18	34	40	14	13	74	26	17	48
10	14	16	14	16	28	40	17	13	28	24	17	37
11	16	14	14	16	56	26	18	13	28	24	17	28
12	24	14	14	14	28	44	14	13	40	24	17	26
13	31	14	13	14	22	56	14	14	107	24	17	26
14	34	18	18	14	20	31	13	13	112	26	18	24
15	18	34	14	16	31	26	13	13	164	26	20	48
16	18	17	17	16	22	34	78	13	83	31	24	65
17	48	20	14	22	31	34	78	13	48	22	26	112
18	40	20	20	40	97	142	26	18	34	20	31	37
19	20	26	20	48	56	78	83	14	56	20	48	31
20	26	22	16	24	83	37	44	14	224	20	83	24
21	40	18	17	20	164	31	22	17	132	18	26	24
22	20	16	34	24	48	28	18	13	56	34	24	22
23	17	14	20	26	28	48	24	13	34	20	24	20
24	17	14	18	65	24	74	24	13	28	20	22	20
25	16	13	18	48	48	31	20	13	40	26	24	20
26	16	13	26	22	44	26	26	13	34	20	28	20
27	26	13	40	28	26	26	18	13	24	20	40	20
28	18	13	34	40	40	52	18	13	24	20	74	20
29	18	14	22	24	107	88	17	.....	22	20	37	20
30	18	13	18	20	74	34	16	.....	22	56	65	18
31	18	13	.....	20	.....	22	14	.....	22	.....	40	.....

NOTE.—Discharge determined from fairly well defined rating curves applicable July 1 to Nov. 21 and Nov. 22 to June 30. Discharge Oct. 29 to Nov. 4 determined from records of flow of Kapahi ditch.

Digitized by Google

Monthly discharge of Kapaa River near Kealia, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	78	14	24.4	37.8	755	2,320
August	37	13	18.6	28.8	577	1,770
September	40	12	17.9	27.7	537	1,650
October	65	14	23.3	36.1	721	2,220
November	164	16	45.5	70.4	1,360	4,190
December	142	22	47.4	73.3	1,470	4,510
January	83	13	26.4	40.8	818	2,510
February	31	13	14.7	22.7	411	1,260
March	224	12	50.9	78.8	1,580	4,840
April	56	18	26.1	40.4	782	2,400
May	83	17	28.9	44.7	896	2,750
June	112	18	34.6	53.5	1,040	3,190
The year	224	12	30.0	46.4	10,900	33,600

KAPAHI DITCH NEAR KEALIA, KAUAI.

LOCATION.—500 feet below intake and about 4 miles west of Kealia.

RECORDS AVAILABLE.—April 15, 1909, to May 2, 1914; May 10, 1915, to June 30, 1917.

GAGE.—Stevens 8-day water-stage recorder, installed May 10, 1915, to replace original Watson recorder.

DISCHARGE MEASUREMENTS.—Made by 20-foot sharp-crested weir immediately below gage.

CHANNEL AND CONTROL.—Channel straight for 50 feet above weir.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 1.98[1] feet at 2 a. m., September 16, 1915 (discharge, 120 million gallons per day, or 186 second-feet); water shut off November 23 and 24, 1916.

DIVERSIONS.—Ditch diverts part of flow of Kapaa River.

REGULATION.—Flow regulated by head gates.

UTILIZATION.—For irrigation of sugar cane and for domestic supply.

ACCURACY.—Conditions at weir fairly good. Records fair for all stages.

[1] Determinations of maximum discharge supersede those published in Water-Supply Paper 430, which were based on extension of rating curve.

Digitized by Google

Daily discharge, in million gallons, of Kapahi ditch near Kealia, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	June.
1	25.2	12.5	11.7	12.1	12.9	5.3	5.0	7.4	11.7	10.9	.....
2	20.0	20.0	12.9	11.3	14.2	7.0	5.0	7.8	11.7	8.1	.....
3	17.5	18.5	9.7	10.5	13.7	6.4	8.9	7.4	11.7	8.9	.....
4	16.5	20.0	9.7	9.7	22.5	6.7	10.5	7.0	16.0	10.9	.....
5	15.2	20.0	9.3	13.7	17.5	6.7	8.9	8.9	14.2	15.2	.....
6	13.7	15.2	9.3	12.1	13.3	15.2	8.9	10.1	15.2	13.7	.....
7	12.9	21.0	10.1	10.5	22.5	8.9	11.7	10.1	15.2	13.7	.....
8	11.7	18.5	10.9	10.5	11.7	12.9	11.7	12.9	14.7	5.3	.....
9	11.3	18.0	10.9	14.2	11.7	9.3	11.7	12.9	14.2	4.4	16.0
10	11.3	15.2	10.9	10.9	11.7	8.9	8.9	12.9	16.0	7.0	16.0
11	12.1	13.3	10.9	10.9	15.2	8.9	7.4	12.1	16.0	16.0	15.6
12	17.5	13.3	10.1	10.5	12.9	8.9	7.4	11.7	15.2	15.2	15.6
13	25.2	12.9	9.7	10.1	15.2	7.0	7.4	10.9	10.9	15.2	15.2
14	25.2	15.2	15.2	10.1	10.9	6.4	7.4	11.7	8.5	12.9	15.2
15	17.5	30.8	10.9	10.9	8.9	6.4	7.4	11.7	8.1	10.9	.....
16	15.2	17.0	12.9	10.9	8.9	6.4	7.8	8.9	6.7	11.3	.....
17	17.5	18.0	10.9	17.5	8.5	6.0	6.4	8.9	6.4	11.7	.....
18	17.5	19.0	15.2	27.8	9.3	5.3	.....	12.9	6.4	12.5	.....
19	16.5	22.5	15.2	33.8	8.9	5.3	.....	12.9	10.9	12.9	.....
20	17.0	20.0	10.9	17.5	8.9	6.4	5.3	10.9	9.3	12.1	.....
21	15.2	18.0	12.9	15.2	9.3	6.7	5.3	10.9	10.9	10.9	.....
22	13.7	15.2	25.2	17.5	8.5	6.7	5.6	12.9	8.1	17.5	.....
23	13.3	13.7	15.2	18.5	.....	6.4	6.7	12.1	7.0	14.2	.....
24	12.5	12.9	12.9	39.8	.....	6.7	6.7	11.7	5.3	12.5	11.7
25	11.3	12.5	12.9	33.8	10.9	6.4	6.7	11.7	5.3	11.7	11.3
26	11.3	12.5	20.0	17.5	7.8	7.0	6.7	11.7	5.3	11.7	10.9
27	13.3	12.9	27.8	18.5	5.3	8.9	10.9	12.1	12.9	11.7	10.5
28	12.9	12.5	27.8	22.5	4.4	7.0	12.1	12.5	16.0	11.7	11.3
29	13.3	12.9	17.5	20.0	4.7	5.3	8.9	.....	16.0	.....	11.3
30	13.3	12.5	13.7	16.0	4.1	5.0	7.4	.....	15.2	.....	10.5
31	13.3	12.1	.....	15.2	.....	5.0	7.4	.....	15.2	.....	.....

NOTE.—Discharge determined by weir formula, $Q=3.33\ LH^{\frac{3}{2}}$. No record on days for which discharge is not given, except Nov. 23 and 24, when water was shut off.

Monthly discharge of Kapahi ditch near Kealia, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	25.2	11.3	15.5	24.0	480	1,470
August	30.8	12.1	16.4	25.4	509	1,560
September	27.8	9.3	13.8	21.4	413	1,270
October	39.8	9.7	16.5	25.5	510	1,570
November (28 days)	22.5	4.1	11.2	17.3	314	962
December	15.2	5.0	7.27	11.2	225	692
February	12.9	7.0	10.9	16.9	306	937
March	16.0	5.3	11.5	17.8	356	1,090
April 1–28	17.5	4.4	11.8	18.3	331	1,010

NOTE.—See footnote to daily-discharge table.

Digitized by Google

ANAHOLA RIVER NEAR KEALIA, KAUAI.

LOCATION.—About a quarter of a mile above dam at Kiokala and 6 miles northwest of Kealia.

RECORDS AVAILABLE.—August 22 to November 2, 1910; December 28, 1912, to June 30, 1917. Fragmentary record December 15, 1910, to December 28, 1912, at dam a quarter of a mile below present site.

GAGE.—Friez water-stage recorder August 22 to November 2, 1910, and December 28, 1912, to June 30, 1917. From December 15, 1910, to December 28, 1912, an inclined staff.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 75 feet above and below gage; right bank steep and high and covered with underbrush; left bank low for about 40 feet from low-water channel then rises abruptly. Control composed of boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.35 feet at 1 a. m. March 20 (discharge, approximately 850 million gallons per day, or 1,320 second-feet); minimum stage recorded, 1.6 feet, September and October (discharge, 3.6 million gallons per day, or 5.6 second-feet).

Maximum stage recorded during period of record, 12.9 feet at 7.30 p. m. September 26, 1914 (discharge, estimated from extension of rating curve, approximately, 1,450 million gallons per day, or 2,240 second-feet); minimum stage recorded, 1.3 feet February 27 and 28, 1915 (discharge, 2 million gallons per day, or 3.1 second-feet).

DIVERSIONS.—Part of flow diverted 3 miles above station.

REGULATION.—None except by diversions.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Determinations based on fairly well defined rating curves and continuous gage-height record. Records fair below 120 million gallons per day.

Discharge measurements of Anahola River near Kealia, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height.	Discharge.	
		Feet.	Second-feet.	Million gallons per day.
Aug. 3	W. V. Hardy	1.79	10	6.5
Oct. 18	do	2.05	29	19
Nov. 21	do	3.06	139	90
Dec. 6	do	2.02	16	10
27	D. E. Horner	1.92	21	13
June 7	do	2.33	47	30
9	do	1.99	19	12

Digitized by Google

Daily discharge, in million gallons, of Anahola River near Kealia, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	14	4.8	4.2	4.8	5.4	14	20	14	9.5	26	16	12
2	8.0	6.0	4.2	4.8	5.4	14	20	18	8.0	14	9.5	11
3	9.5	6.0	3.6	4.2	5.4	11	46	14	8.0	16	9.5	11
4	11	9.5	4.2	4.2	6.0	14	33	12	9.5	12	8.0	11
5	7.0	7.0	4.2	4.2	6.0	16	42	12	9.5	12	7.0	9.5
6	6.0	5.4	3.6	4.2	5.4	18	20	12	11	11	7.0	16
7	6.0	8.0	3.6	3.6	5.4	60	16	12	26	11	7.0	50
8	5.4	6.0	3.6	4.2	7.0	37	16	11	37	11	7.0	16
9	5.4	7.0	3.6	4.8	6.0	23	16	9.5	114	11	7.0	12
10	5.4	5.4	3.6	4.2	7.0	20	20	9.5	.....	11	7.0	9.5
11	5.4	4.8	3.6	3.6	8.0	12	18	9.5	.....	11	7.0	9.5
12	6.0	4.8	3.6	3.6	7.0	12	12	9.5	.....	9.5	7.0	9.5
13	6.0	5.4	3.6	3.6	6.0	23	12	11	.....	9.5	7.0	9.5
14	16	5.4	4.2	5.4	5.4	14	11	16	.....	16	7.0	8.0
15	8.0	9.5	3.6	4.2	8.0	11	11	9.5	.....	9.5	7.0	9.5
16	8.0	6.0	3.6	4.8	6.0	12	80	9.5	.....	9.5	9.5	33
17	9.5	6.0	3.6	6.0	5.4	12	114	9.5	.....	8.0	8.0	46
18	16	6.0	4.2	14	46	75	42	12	65	8.0	18	11
19	8.0	6.0	4.2	8.0	14	55	114	11	60	7.0	37	9.5
20	8.0	6.0	4.2	5.4	16	23	65	16	239	7.0	55	9.5
21	11	6.0	4.2	7.0	114	18	33	16	148	7.0	16	8.0
22	7.0	5.4	6.0	6.0	33	16	29	11	80	16	12	8.0
23	6.0	4.8	6.0	6.0	14	20	26	9.5	50	9.5	11	8.0
24	6.0	4.8	4.8	18	11	46	26	9.5	37	8.0	9.5	8.0
25	5.4	4.8	4.8	12	14	18	29	9.5	42	11	9.5	46
26	5.4	4.8	4.2	7.0	12	16	18	9.5	42	9.5	9.5	14
27	5.4	4.8	6.0	6.0	9.5	23	18	12	23	11	12	46
28	5.4	4.8	11	6.0	20	26	18	9.5	16	9.5	26	14
29	6.0	4.8	5.4	6.0	46	97	29	.....	16	8.0	14	12
30	6.0	4.8	4.8	5.4	18	37	18	.....	14	20	20	11
31	5.4	4.8	.....	5.4	.....	26	16	.....	14	.....	18	.....

NOTE.—Discharge determined from rating curves fairly well defined below 120 million gallons per day applicable July 1 to Dec. 18, Dec. 19 to Mar. 9, Mar. 18 to June 30. Gage height not recorded Mar. 10–17.

Monthly discharge of Anahola River near Kealia, Kauai, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	16	5.4	7.66	11.9	238	729
August	9.5	4.8	5.79	8.96	180	551
September	11	3.6	4.47	6.92	134	412
October	18	3.6	6.02	9.31	187	573
November	114	5.4	15.7	24.3	472	1,450
December	97	11	26.4	40.8	819	2,510
January	114	11	31.9	49.4	988	3,030
February	18	9.5	11.6	17.9	326	997
April	26	7.0	11.3	17.5	340	1,040
May	55	7.0	13.1	20.3	405	1,250
June	50	8.0	16.3	25.2	488	1,500

ANAHOLA DITCH ABOVE KANEHA RESERVOIR, NEAR KEALIA, KAUAI.

LOCATION.—At lower end of third tunnel above Kaneha reservoir, 7 miles from Kealia.

RECORDS AVAILABLE.—May 30, 1915, to June 30, 1917.

GAGE.—Stevens 8-day water-stage recorder.

DISCHARGE MEASUREMENTS.—Made from wooden footbridge at gage.

CHANNEL AND CONTROL.—Channel at gage is short straight stretch of open ditch cut in firm earth between two tunnels. Control rock section of ditch; probably permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded, 3.72 feet at 4.30 a. m. January 26, 1916 (discharge, 53 million gallons per day, or 82 second-feet); minimum stage recorded, 1.0 foot January 1, 1916 (discharge, 0.9 million gallons per day, or 1.4 second-feet).

DIVERSIONS.—Ditch diverts from Anahola River.

REGULATION.—By head gates. When Kaneha reservoir is full water is turned out of ditch at spillway just below gage.

UTILIZATION.—Water is stored in Kaneha reservoir for irrigation of sugar cane and for domestic supply.

ACCURACY.—Discharge ascertained from well-defined rating curve and a continuous gage-height record. Records good except for days when water was turned out at spillway.

Discharge measurements of Anahola ditch above Kaneha reservoir, near Kealia, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Oct. 9	W. V. Hardy	1.70	11	7.2
Nov. 19	do	1.84	14	9.4
Dec. 26	D. E. Horner	1.36	5.9	3.8
29	do	.99	2.6	1.7
Mar. 8	W. V. Hardy	1.49	7.0	4.5
Apr. 1	do	1.76	13	8.5
May 30	do	1.53	7.9	5.1

Daily discharge, in million gallons, of Anahola ditch above Kaneha reservoir, near Kealia, Kauai, for the year ending June 30, 1917.

Date.	July	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1	23	3.0	4.9	8.2	5.4	3.9	1.9	9.6	11	5.4
2	7.0	2.6	7.6	8.2	4.4	7.0	1.9	12	4.9	4.9
3	14	2.6	4.9	7.6	4.9	3.9	1.9	9.6	3.9	5.9
4	.....	2.2	8.9	8.9	4.9	3.9	4.9	5.9	3.4	5.9
5	.....	3.0	7.6	7.6	5.9	3.4	4.4	4.4	3.0	4.9
6	.....	2.2	4.9	8.9	6.4	3.4	6.4	3.9	3.0	6.4
7	.....	1.9	8.2	12	5.9	3.0	14	3.9	2.6	8.2
8	3.9	2.2	11	10	5.4	2.6	7.0	4.9	2.6	7.0
9	3.4	4.9	9.6	8.9	4.9	2.6	18	7.0	2.6	7.0
10	3.9	2.2	5.9	8.2	5.9	2.6	3.9	5.4	2.6	6.4
11	4.4	2.2	9.6	6.4	5.9	2.6	3.4	5.9	2.2	5.4
12	6.4	1.9	5.9	7.6	4.9	2.6	3.4	7.0	2.2	5.4
13	5.9	2.2	4.9	9.6	3.9	3.0	8.9	9.6	2.2	5.4
14	12	3.9	3.9	7.6	3.9	4.9	3.9	22	2.6	4.9
15	4.4	2.2	8.9	5.9	3.4	2.6	5.9	13	3.0	5.9
16	4.4	2.2	4.9	7.6	5.9	2.6	3.4	9.6	4.4	8.2
17	10	7.0	4.4	7.0	3.4	2.2	4.4	4.4	4.4	8.2
18	14	15	24	11	2.6	3.9	3.4	3.9	14	7.0
19	4.9	12	8.2	9.6	3.9	3.0	9.6	3.4	20	5.9
20	5.4	7.0	.....	8.9	4.4	3.0	12	3.0	14	4.9
21	8.2	9.6	.....	7.6	4.9	4.4	4.4	3.0	5.9	4.4
22	.....	7.0	10	7.6	5.4	2.6	4.9	10	4.4	3.9
23	.....	8.2	7.6	8.2	4.9	2.2	4.9	4.4	3.9	3.4
24	.....	28	6.4	8.9	4.9	1.9	4.4	3.9	3.4	3.0
25	.....	16	7.6	7.6	5.4	1.9	4.9	5.4	3.0	3.0
26	.....	6.4	8.2	6.4	4.9	1.9	5.4	3.9	3.0	2.6
27	.....	5.9	5.9	3.9	5.4	3.4	7.0	4.9	5.9	2.6
28	.....	7.0	7.6	3.0	6.4	3.0	6.4	4.4	9.6	3.0
29	.....	8.2	9.6	4.4	7.6	.....	5.9	3.9	7.6	2.6
30	.....	7.0	8.2	3.9	4.9	.....	5.4	15	5.4	2.2
31	.....	5.4	.....	5.4	3.9	.....	5.4	.....	4.4	.....

NOTE.—Discharge determined from rating curve well defined below 20 million gallons per day. No record July 4–7 and Nov. 20 and 21. Record sheets July 22 to Sept. 30 lost by observer. Water spilling below gage Nov. 22, 29 and 30, Dec. 1–3, 7–10, 18–31, Jan. 1, 2, 16–22, 30 and 31, Feb. 1–7, 20, 21, Mar. 9, 13–27, Apr. 2, 3, 7–18, and May 19–21.

Digitized by Google

Monthly discharge of Anahola ditch above Kaneha reservoir near Kealia, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
October	28	1.9	6.16	9.53	191	586
December	12	3.0	7.63	11.8	237	726
January	7.6	2.6	4.99	7.72	155	475
February	7.0	1.9	3.14	4.86	88	270
March	18	1.9	5.86	9.07	182	557
April	22	3.0	6.91	10.7	207	636
May	20	2.2	5.33	8.25	165	507
June	8.2	2.2	5.13	7.94	154	472

NOTE.—See footnote to daily-discharge table.

KALIHIWAI RIVER NEAR HANALEI, KAUAI.

LOCATION.—At elevation 700 feet, 1 mile east of Kauai Electric Co.'s power line, about 9 miles southeast of Hanalei.

RECORDS AVAILABLE.—March 13, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and 50 feet below gage; current sluggish at low stages; right bank low and wooded; left bank a high and nearly vertical cliff. Control composed of large boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.4 feet at 3 a. m. March 20 (discharge, approximately 2,000 million gallons per day, or 3,090 second-feet); minimum stage recorded, 0.75 foot September 4 and 6 (discharge, 7 million gallons per day, or 11 second-feet).

Maximum stage recorded during period of record, 14.4 feet at 6.30 a. m. September 25, 1914 (discharge, computed from extension of rating curve, approximately 4,000 million gallons per day, or 6,200 second-feet); minimum stage recorded, 0.95 foot March 13, 1914 (discharge, 6.5 million gallons per day, or 10 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Part of flow is diverted below station for irrigation of rice and taro.

ACCURACY.—Discharge ascertained from well-defined rating curve and a continuous gage-height record. Records good below 600 million gallons per day.

Discharge measurements of Kalihiwai River near Hanalei, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 25	D. E. Horner	1.00	22	14
Sept. 22	W. V. Hardy	1.12	26	17
Jan. 14	D. E. Horner	.98	19	12
June 19	....do	1.32	44	28

Digitized by Google

Daily discharge, in million gallons, of Kalihiwai River near Hanalei, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	58	13	8	13	24	53	22	15	15	22	43	.....
2	24	27	9	12	24	38	30	27	20	20	22	.....
3	43	27	8	10	20	43	63	17	17	34	.....	.....
4	43	53	7	10	34	101	34	15	17	13	.....	.....
5	22	53	8	12	27	53	53	13	15	.....	.....	.....
6	20	17	7	10	20	58	27	13	20	.....	.....	.....
7	17	34	12	9	48	63	22	12	30	.....	.....	.....
8	15	22	9	9	68	34	20	12	20	.....	.....	.....
9	15	20	9	12	68	30	20	12	119	.....	.....	.....
10	17	15	9	9	34	27	22	12	34	.....	.....	.....
11	15	15	10	8	43	20	20	12	30	.....	.....	.....
12	24	15	9	8	24	24	17	10	30	.....	.....	.....
13	30	15	8	9	20	38	15	10	95	.....	.....	.....
14	34	17	9	12	17	22	13	13	131	.....	.....	.....
15	20	34	9	10	30	17	13	12	144	.....	.....	.....
16	24	17	9	12	20	27	78	12	151	.....	.....	.....
17	68	20	10	22	22	30	119	12	73	24	.....	.....
18	48	20	13	48	95	166	38	15	53	22	.....	.....
19	24	30	13	53	27	73	138	12	48	20	.....	.....
20	27	27	12	27	48	34	63	10	234	17	.....	22
21	30	15	12	24	151	27	34	13	131	17	.....	22
22	20	17	30	22	53	24	24	9	68	30	.....	20
23	15	13	17	27	30	48	30	9	68	17	.....	17
24	13	12	15	73	24	63	43	9	17	15	.....	17
25	13	10	15	73	43	24	24	9	13	17	.....	17
26	12	9	43	30	34	20	27	9	24	15	.....	17
27	22	9	48	30	22	20	22	10	17	17	.....	17
28	15	9	53	68	58	27	22	15	15	15	.....	17
29	13	9	22	73	83	83	22	.....	13	15	.....	15
30	12	8	15	53	78	34	17	.....	13	43	.....	15
31	15	8	.....	34	.....	24	17	.....	12	.....	.....	.....

NOTE.—Discharge determined from rating curve well defined below 600 million gallons per day. Gage heights not recorded on days for which discharge is not given.

Monthly discharge of Kalihiwai River near Hanalei, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	68	12	24.8	38.4	768	2,360
August	53	8	19.7	30.5	610	1,870
September	53	7	15.3	23.7	458	1,410
October	73	8	26.5	41.0	822	2,520
November	151	17	43.0	66.5	1,290	3,960
December	166	17	43.4	67.1	1,340	4,130
January	138	13	35.8	55.4	1,110	3,410
February	27	9	12.5	19.3	349	1,070
March	234	12	54.4	84.2	1,690	5,180
June 20-30	22	15	17.8	27.5	196	602

HANALEI RIVER AT ELEVATION 625 FEET,[1] NEAR HANALEI, KAUAI.

LOCATION.—Two miles west of Kauai Electric Co.'s power line and 10 miles south of Hanalei. Trail to station leaves power line at pole No. 485.

RECORDS AVAILABLE.—January 26, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder; datum raised 6.0 feet January 15, 1915.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below gage. Stream bed rough; right bank steep and high; left bank slopes gently. Control composed of boulders; shifting.

[1] Corrected elevation; formerly published as 750 feet.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.05 feet at 11 a. m. March 14 (discharge, approximately 2,260 million gallons per day, or 3,500 second-feet); minimum stage recorded, 0.6 foot September 4, 5, and 19 (discharge, 29 million gallons per day, or 45 second-feet).

Maximum stage recorded during period of record, 9.7 feet (new datum) September 26, 1914 (discharge, computed from extensions of rating curve, approximately 3,800 million gallons per day, or 5,880 second-feet); minimum stage recorded, 0.4 foot (new datum) March, 1914 (discharge, 24 million gallons per day, or 37 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation, power, and domestic supply.

ACCURACY.—Records good.

Discharge measurements of Hanalei River at elevation 625 feet, near Hanalei, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Sept. 29	W. V. Hardy	1.27	124	80
Nov. 15	D. E. Horner	1.43	158	102
Jan. 15	do	.76	65	42
June 19	do	1.02	109	70

Daily discharge, in million gallons, of Hanalei River at elevation 625 feet, near Hanalei, Kauai, for the year ending June 30, 1912.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	59	43	32	50	82	152	102	48	65	.....	224	236
2	54	76	34	43	70	118	148	158	65	.....	119	128
3	110	102	32	40	59	82	128	79	72	.....	72	102
4	110	102	32	37	70	183	190	.....	86	.....	94	86
5	64	82	29	43	126	102	148	.....	86	.....	65	102
6	50	64	29	43	88	82	168	.....	79	.....	48	102
7	43	64	37	37	143	110	102	.....	110	.....	43	224
8	40	76	37	37	255	88	79	.....	102	.....	39	390
9	37	70	43	40	194	70	65	.....	390	.....	35	190
10	37	54	40	37	102	102	59	.....	605	.....	39	110
11	37	46	37	37	110	59	59	.....	249	.....	27	79
12	46	43	37	40	88	59	53	.....	236	.....	27	65
13	64	43	37	43	64	64	48	.....	625	.....	24	65
14	102	40	34	40	50	76	43	.....	935	.....	31	53
15	64	70	32	40	64	59	39	.....	465	.....	31	65
16	64	70	32	40	54	54	249	.....	262	.....	39	119
17	228	54	34	46	50	76	505	.....	148	72	43	276
18	143	76	32	64	183	118	168	.....	79	65	224	110
19	76	76	29	110	88	835	935	94	79	53	505	72
20	82	88	34	88	88	201	372	86	128	48	249	59
21	88	102	37	70	335	128	148	86	119	43	128	43
22	70	76	70	59	118	110	119	86	79	48	79	39
23	54	54	59	70	76	148	128	86	94	65	65	35
24	46	43	54	88	64	445	290	79	79	48	59	31
25	43	40	50	390	70	224	128	79	59	48	59	31
26	43	37	152	134	95	110	102	65	212	43	48	27
27	50	34	143	82	64	94	86	72	138	43	79	27
28	43	34	143	318	88	86	79	79	94	43	110	27
29	43	34	88	410	152	236	72	.....	79	39	94	27
30	43	32	59	172	228	224	65	.....	.....	79	148	27
31	43	32	.....	126	.....	128	53	.....	.....	.....	158	.....

NOTE.—Discharge determined from fairly well defined rating curves applicable as follows: July 1 to Dec. 18 and Dec. 19 to June 30. Gage heights not recorded Feb. 4–18 and Mar. 30 to Apr. 16.

Digitized by Google

Monthly discharge of Hanalei River at elevation 625 feet, near Hanalei, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	228	37	67.0	104	2,080	6,370
August	102	32	59.9	92.7	1,860	5,700
September	152	29	51.3	79.4	1,540	4,720
October	410	37	92.7	143	2,870	8,820
November	335	50	111	172	3,320	10,200
December	835	54	149	230	4,620	14,200
January	935	39	159	246	4,930	15,100
Mar. 1-29	935	59	201	311	5,820	17,900
Apr. 17-30	79	39	52.6	81.4	737	2,260
May	505	24	96.9	150	3,000	9,220
June	390	27	98.2	152	2,950	9,040

HANALEI RIVER NEAR HANALEI, KAUAI.

LOCATION.—About 5 miles up the river from Hanalei.

RECORDS AVAILABLE.—December 28, 1911, to June 30, 1917.

GAGE.—Inclined and vertical staff on left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—One channel at all stages; straight for 500 feet above and below gage; banks low, wooded, and not subject to overflow. Control composed of boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.55 feet December 18 (discharge, approximately 8,000 million gallons per day, or 12,400 second-feet); minimum stage recorded, 6.6 feet in September (discharge, 53 million gallons per day, or 82 second-feet).

Maximum stage recorded during period of record, 17.52 feet at 4 p. m. September 26, 1914 (discharge, computed from extension of rating curve, approximately 14,000 million gallons per day, or 21,700 second-feet); minimum stage recorded, 6.21 feet March 25, 1914 (discharge, 26 million gallons per day, or 40 second-feet).

DIVERSIONS.—China ditch diverts water above station.

REGULATION.—By diversions only.

UTILIZATION.—Most of the water passing the station is wasted, but a small amount is diverted for irrigation of rice and taro.

ACCURACY.—Gage read twice daily. Discharge determined from rating curve well defined below 1,000 million gallons per day. Records fair for all stages.

Discharge measurements of Hanalei River near Hanalei, Kauai, during the year ending June 30, 1917.

[Made by D. E. Horner.]

Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.
July 28	6.71	134	69
Apr. 26	6.88	143	92
May 9	6.76	113	73

Digitized by Google

Daily discharge, in million gallons, of Hanalei River near Hanalei, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	320	73	53	95	164	400	180	108	73	134	1,060	320
2	120	164	63	84	370	320	200	320	63	120	148	148
3	164	148	53	73	520	180	320	134	63	200	120	148
4	164	200	63	73	320	580	295	120	108	120	180	148
5	120	120	53	73	295	460	680	120	95	108	108	180
6	95	95	53	73	270	400	180	108	148	108	95	270
7	84	200	95	63	345	645	164	95	295	108	84	1,240
8	73	148	63	63	1,140	430	148	84	120	95	73	460
9	73	95	95	95	610	164	134	84	715	120	73	430
10	73	95	73	73	220	164	180	84	148	148	95	200
11	84	95	73	63	180	148	164	84	148	134	95	164
12	73	84	53	63	164	180	134	73	550	320	84	148
13	164	84	73	73	134	200	120	84	890	270	84	108
14	270	84	53	95	120	148	108	84	3,500	164	95	108
15	148	200	53	73	200	120	108	84	3,670	164	63	108
16	164	95	53	95	148	180	1,240	73	2,600	180	73	645
17	610	148	73	120	120	148	1,170	73	370	134	120	1,400
18	270	164	73	164	460	2,450	295	73	320	120	820	220
19	134	148	73	370	164	785	2,350	84	180	108	1,600	164
20	148	200	63	164	148	270	460	73	1,360	95	750	148
21	180	134	63	120	1,030	200	245	84	785	95	925	148
22	108	134	680	148	295	220	220	73	370	108	490	120
23	95	84	245	164	180	370	148	73	220	164	148	95
24	84	180	95	370	148	750	295	180	180	95	134	95
25	73	84	95	960	220	245	245	148	245	95	120	84
26	148	73	960	200	220	180	164	148	1,030	95	134	84
27	370	73	245	220	148	245	148	120	245	95	108	84
28	73	63	220	785	220	270	164	108	220	95	95	84
29	73	73	134	680	320	1,400	164	.....	164	95	164	84
30	63	63	108	320	550	295	164	.....	148	180	295	84
31	95	63	.....	245	.....	200	134	.....	134	.....	400	.....

NOTE.—Discharge determined from rating curve well defined below 1,000 million gallons per day.

Monthly discharge of Hanalei River near Hanalei, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	610	63	152	235	4,710	14,500
August	200	63	118	183	3,660	11,200
September	960	53	138	214	4,150	12,700
October	960	63	202	313	6,260	19,200
November	1,140	120	314	486	9,420	28,900
December	2,450	120	411	636	12,700	39,100
January	2,350	108	346	535	10,700	32,900
February	320	73	106	164	2,980	9,110
March	3,670	63	618	956	19,200	58,800
April	320	95	136	210	4,070	12,500
May	1,600	63	285	441	8,830	27,100
June	1,400	84	257	398	7,720	23,700
The year	3,670	53	259	401	94,400	290,000

CHINA DITCH NEAR HANALEI, KAUAI.

LOCATION.—Just below intake, about 5 miles south of Hanalei.

RECORDS AVAILABLE.—March 17, 1914, to June 30, 1917. December 28, 1911, to September 30, 1913, at old station a quarter of a mile below present station.

GAGE.—Vertical staff on left bank.

DISCHARGE MEASUREMENTS.—Made from plank.

Digitized by Google

CHANNEL AND CONTROL.—Cut in clay and gravel; subject to growth of grass and weeds which affects stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.55 feet June 7 (discharge, 32 million gallons per day, or 50 second-feet); minimum stage recorded, 0.45 foot January 15 (discharge, 8.8 million gallons per day, or 13.6 second-feet).

DIVERSIONS.—Ditch diverts part of flow of Hanalei River.

REGULATION.—By head gates.

UTILIZATION.—Irrigation of rice and taro.

ACCURACY.—Gage read twice daily. Stage-discharge relation rather unstable owing to growth of aquatic plants. Records July 1 to October 31 poor; those for November 1 to June 30 fair for all stages.

Discharge measurements of China ditch near Hanalei, Kauai, during the year ending June 30, 1917.

[Made by D. E. Horner.]

Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.
July 28	1.80	39	25
Nov. 26	1.55	32	20
Apr. 26	1.48	30	19
May 10	1.18	24	16

Daily discharge, in million gallons, of China ditch near Hanalei, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	28	26	22	20	22	22	10	22	16	18	24	21
2	25	27	22	18	22	22	11	14	16	18	18	20
3	26	27	21	18	20	21	12	11	16	21	17	19
4	25	28	22	18	24	24	12	10	18	18	19	19
5	24	26	20	18	23	22	14	10	18	18	16	19
6	23	26	21	18	22	20	10	10	18	18	16	20
7	23	24	23	16	24	24	10	10	21	18	16	27
8	23	22	22	16	25	21	9.6	16	18	17	16	22
9	22	26	23	17	24	20	9.6	16	22	18	16	22
10	23	25	22	16	22	20	12	16	18	18	16	19
11	24	24	22	16	22	18	10	16	18	18	16	18
12	26	24	20	16	21	18	9.6	16	21	22	16	18
13	27	25	19	18	19	20	9.1	16	22	22	16	18
14	28	24	19	18	18	18	9.1	18	28	18	16	21
15	28	23	19	18	22	18	8.8	18	27	21	17	24
16	28	25	19	19	19	19	21	17	24	19	18	26
17	28	26	21	21	18	18	21	16	17	18	20	28
18	27	27	22	22	24	24	11	18	16	18	26	22
19	25	26	22	24	22	18	25	18	14	18	27	20
20	26	27	21	22	20	12	14	17	23	17	22	19
21	26	26	21	22	25	12	11	18	18	17	22	19
22	25	26	20	21	23	12	10	16	16	17	19	19
23	24	24	26	22	21	14	9.6	16	14	16	19	18
24	23	24	23	24	20	19	12	16	14	16	18	18
25	24	24	23	26	22	11	10	16	14	17	18	18
26	25	24	26	22	22	10	10	16	20	19	18	18
27	26	23	20	22	19	11	11	18	15	18	18	18
28	25	23	21	26	22	12	12	16	14	18	19	18
29	25	22	22	26	23	18	12	.....	14	17	18	18
30	26	22	22	26	24	12	11	.....	14	16	20	18
31	25	22	.....	24	.....	11	10	.....	16	.....	22	.....

NOTE.—Discharge July 1 to Oct. 31 determined by shifting-control method; Nov. 1 to June 30 from well-defined rating curve.

Digitized by Google

Monthly discharge of China ditch near Hanalei, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	28	22	25.3	39.1	783	2,410
August	28	22	24.8	38.4	768	2,360
September	26	19	21.5	33.3	646	1,980
October	26	16	20.3	31.4	630	1,930
November	25	18	21.8	33.7	654	2,010
December	24	10	17.5	27.1	541	1,660
January	25	8.8	11.9	18.4	367	1,130
February	22	10	15.6	24.1	437	1,340
March	28	14	18.1	28.0	560	1,720
April	22	16	18.1	28.0	544	1,670
May	27	16	18.7	28.9	579	1,780
June	28	18	20.1	31.1	604	1,850
The year	28	8.8	19.5	30.2	7,110	21,800

KUNA DITCH NEAR HANALEI, KAUAI.

LOCATION.—A quarter of a mile below intake and about 3 miles southeast of Hanalei.

RECORDS AVAILABLE.—July 1, 1916, to June 30, 1917. January 17, 1912, to September 30, 1913, at old site 500 feet below intake.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made from plank at gage.

CHANNEL AND CONTROL.—Channel about 5 feet wide and 3 feet deep, cut in firm earth. Stage-discharge relation sometimes affected by growth of grass in channel.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.3 feet April 3 (discharge, 36 million gallons per day, or 56 second-feet); minimum stage recorded, 0.9 foot January 25 (discharge, 3.2 million gallons per day, or 5 second-feet).

DIVERSIONS.—None above station.

REGULATION.—By head gates.

UTILIZATION.—Irrigation of rice and taro.

ACCURACY.—Gage read twice daily. Determinations based on rating curves well defined between 10 and 25 million gallons per day. Records fair for ordinary stages.

Discharge measurements of Kuna ditch near Hanalei, Kauai, during the year ending June 30, 1917.

[Made by D. E. Horner.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 28	2.19	28	18	Jan. 16	1.82	20	13
Nov. 20	1.87	20	13	Apr. 12	2.26	16	17
26	1.91	22	14	May 10	2.67	30	19

Digitized by Google

Daily discharge, in million gallons, of Kuna ditch near Hanalei, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	20	18	14	12	13	18	6.6	9.8	18	30	.....	15
2	18	24	15	12	13	16	10	12	18	24	16	18
3	18	24	6.1	10	12	14	6.6	10	18	33	18	11
4	20	25	9.8	10	14	.....	5.6	9.8	23	26	.....	11
5	20	20	14	11	14	15	.....	9.8	21	27	16	11
6	16	19	14	10	15	14	5.6	17	24	25	15	28
7	15	26	20	10	15	.....	5.6	24	24	24	14	.....
8	14	23	16	9.8	.....	14	5.2	22	21	24	14	.....
9	12	20	23	11	18	14	5.2	22	.....	14	14	.....
10	15	20	17	10	14	14	6.1	21	18	24	19	11
11	18	19	17	10	14	13	5.6	21	26	24	19	11
12	20	18	14	9.8	14	14	4.8	21	.....	22	18	11
13	23	19	14	11	12	14	5.2	20	.....	26	18	11
14	25	18	14	11	12	13	4.8	24	.....	26	18	10
15	21	25	14	10	14	12	4.8	21	.....	27	19	11
16	21	20	8.6	11	12	14	.....	20	.....	24	23	.....
17	.....	22	16	12	12	14	.....	20	20	24	24	.....
18	23	20	18	12	16	.....	5.6	22	18	22	.....	.....
19	19	18	18	16	15	.....	.....	21	17	21	.....	12
20	20	26	17	13	14	14	4.8	20	.....	20	.....	15
21	20	23	15	12	.....	14	4.4	21	.....	19	18	15
22	18	21	.....	12	17	14	4.0	19	19	21	17	18
23	15	18	19	13	14	15	3.6	19	17	18	12	18
24	17	18	20	16	14	.....	4.0	18	15	21	11	18
25	15	18	20	.....	16	15	3.2	18	21	21	12	23
26	15	17	.....	14	17	13	11	18	.....	23	12	23
27	18	17	18	14	14	14	10	20	20	21	12	22
28	18	16	17	.....	.....	12	12	18	18	24	17	23
29	17	17	20	.....	18	.....	12	.....	17	23	17	22
30	17	15	13	17	.....	7.6	10	.....	16	21	21	21
31	19	15	.....	14	.....	7.1	9.8	.....	15	.....	21	.....

NOTE.—Discharge determined from rating curves well defined between 10 and 25 million gallons per day, applicable July 1 to April 3 and April 4 to June 30. On days for which discharge is not given the gage was inaccessible on account of high water in Hanalei River.

LUMAHAI RIVER NEAR HANALEI, KAUAI.

LOCATION.—About 6 miles above mouth and 10 miles by road and trail from Hanalei.

RECORDS AVAILABLE.—May 23, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made from cable or by wading.

CHANNEL AND CONTROL.—One channel at all stages; straight for 50 feet above and 100 feet below gage; stream bed very rough; right bank vertical; left bank slopes gently. Control composed of boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 9.0 feet at 3 a. m. December 19, 1916 (discharge, computed from extension of rating curve, approximately 4,600 million per day, or 7,120 second-feet); minimum stage recorded, 0.6 foot April, 1915 (discharge, 20 million gallons per day, or 31 second-feet).

Minimum stage recorded during year, 0.55 foot September 13–17 (discharge, 30 million gallons per day, or 46 second-feet).

DIVERSIONS.—None above station.

REGULATIONS.—None.

UTILIZATION.—Small part of flow is diverted for irrigation of rice and taro.

ACCURACY.—Determination of discharge based on a continuous record of gage heights and well-defined rating curves. Records good for all stages.

Digitized by Google

Discharge measurements of Lumahai River near Hanalei, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 27	W. V. Hardy	0.67	68	44
Sept. 27	do	1.18	178	115
Apr. 18	do	.40	84	54
26	D. E. Horner	.22	53	34
27	do	.30	57	37
30	do	.68	117	75
May 1	do	2.11	606	392
1	do	1.65	357	231
June 15	do	.40	75	48

Daily discharge, in million gallons, of Lumahai River near Hanalei, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	70	39	39	178	102	178	297	43	43	47	113	77
2	50	78	39	178	120	148	218	101	39	47	66	52
3	63	102	34	178	120	102	369	56	43	43	47	47
4	158	70	34	178	189	200	280	52	107	47	47	56
5	158	78	34	178	102	168	248	47	95	43	43	89
6	86	50	34	178	70	158	156	47	113	47	43	126
7	70	63	56	178	86	200	140	47	95	47	43	89
8	56	78	44	178	78	111	89	47	72	47	39	107
9	56	50	44	189	44	94	66	47	101	52	39	77
10	56	44	39	189	56	200	61	47	61	.....	43	61
11	56	39	34	178	86	102	56	47	52	.....	43	52
12	50	44	34	212	120	148	56	43	47	.....	39	47
13	86	50	30	225	168	148	47	52	66	.....	43	47
14	86	39	30	225	178	158	47	66	248	.....	43	43
15	148	78	30	212	250	148	43	47	148	.....	43	52
16	86	56	30	225	265	212	218	47	113	.....	56	140
17	120	44	30	200	280	225	428	47	101	47	77	148
18	178	78	39	178	362	790	107	61	95	47	428	89
19	138	63	50	138	200	790	280	56	95	47	314	66
20	78	78	39	178	158	264	165	47	77	43	101	56
21	78	78	44	178	450	264	83	56	61	43	66	47
22	78	63	56	225	129	264	66	47	52	43	52	47
23	63	44	70	295	78	468	61	43	56	47	52	43
24	56	39	63	345	63	468	140	43	52	39	47	43
25	50	34	56	265	78	264	72	43	47	39	47	39
26	50	34	50	138	86	218	61	43	107	36	43	39
27	39	34	102	78	86	194	56	47	52	43	52	39
28	39	39	148	111	295	297	56	52	47	39	56	43
29	39	39	138	178	398	369	56	.....	47	43	47	39
30	39	39	168	63	432	194	52	.....	43	56	56	39
31	39	39	.....	94	.....	165	47	.....	43	.....	56	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1 to Dec. 19, well defined below 300 million gallons per day; Dec. 20 to June 30, well defined below 600 million gallons per day. Gage heights not recorded Apr. 10–16.

Digitized by Google

Monthly discharge of Lumahai River near Hanalei, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	178	39	78.0	121	2,420	7,430
August	102	34	54.9	84.9	1,700	5,220
September	168	30	54.6	84.5	1,640	5,030
October	345	63	185	286	5,740	17,600
November	450	44	171	265	5,130	15,700
December	790	94	249	385	7,710	23,700
January	428	43	133	206	4,120	12,700
February	101	43	50.8	78.6	1,420	4,370
March	248	39	78.0	121	2,420	7,430
May	428	39	73.7	114	2,280	7,010
June	148	39	64.6	100	1,940	5,950

WAIOLI STREAM NEAR HANALEI, KAUAI.

LOCATION.—3 miles above mouth of stream and 4 miles from Hanalei.

RECORDS AVAILABLE.—June 30, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable at gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 50 feet above and 20 feet below gage; right bank steep; left bank slopes gently. Control composed of boulders; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 6.15 feet at 6.30 a. m. December 19, 1916 (discharge, computed from extension of rating curve, approximately 1,200 million gallons per day, or 1,860 second-feet); minimum stage recorded, 0.6 foot July 22, 1914 (discharge, 2.0 million gallons per day, or 3.1 second-feet).

Minimum stage recorded during year, 1.0 foot November 13 (discharge, 6.0 million gallons per day, or 9.3 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Small part of flow is diverted for irrigation of rice and taro.

ACCURACY.—Determinations of discharge based on well-defined rating curve and a continuous record of gage heights. Records good for all stages.

Discharge measurements of Waioli Stream near Hanalei, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Sept. 30	W. V. Hardy	1.26	22	14
Nov. 21	D. E. Horner	2.80	402	260
Apr. 19	do	1.28	18	12
20	do	1.20	17	11
June 14	do	1.20	16	10.5

Digitized by Google

Daily discharge, in million gallons, of Waioli Stream near Hanalei, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	18	14	9.5	14	16	32	16	11	11	16	94	.....
2	14	14	9.5	14	14	28	48	22	8.0	19	43	.....
3	14	16	9.5	11	19	16	53	11	8.0	19	28	86
4	14	14	11	11	28	72	86	9.5	28	16	25	.....
5	32	14	14	11	48	19	32	8.0	32	14	22	.....
6	19	14	11	11	35	11	32	8.0	35	11	19	.....
7	25	14	11	9.5	25	25	16	8.0	39	9.5	16	.....
8	25	14	9.5	9.5	39	14	11	8.0	28	9.5	16	.....
9	14	22	11	11	35	16	11	8.0	28	9.5	14	.....
10	11	22	9.5	11	16	25	7.0	8.0	16	9.5	14	19
11	11	32	9.5	11	11	11	22	8.0	14	11	14	16
12	22	19	9.5	11	9.5	16	16	8.0	16	11	14	.....
13	32	14	9.5	14	6.0	19	11	8.0	59	11	14	.....
14	19	32	11	11	25	22	9.5	28	78	11	22	.....
15	28	22	16	9.5	11	11	8.0	11	35	16	16	.....
16	32	14	11	16	.....	16	94	9.5	25	22	35	.....
17	43	14	11	16	.....	32	226	8.0	22	19	35	.....
18	25	14	14	16	.....	59	35	8.0	14	16	179	.....
19	25	14	11	28	336	310	102	16	19	16	138	.....
20	35	16	8.0	22	336	35	53	9.5	22	11	53	.....
21	39	16	8.0	19	179	28	22	19	35	11	32	.....
22	43	53	8.0	39	28	32	16	14	22	11	22	.....
23	48	19	8.0	25	14	65	14	9.5	22	16	22	.....
24	53	19	8.0	53	11	168	53	8.0	14	22	22	.....
25	35	25	9.5	59	16	59	19	8.0	16	19	25	.....
26	19	22	11	48	19	16	16	8.0	86	16	22	.....
27	22	28	14	43	11	11	16	9.5	35	25	.....	.....
28	16	22	16	59	43	22	28	32	28	25	.....	.....
29	16	16	9.5	78	48	78	32	.....	22	25	.....	.....
30	11	14	14	25	86	35	22	.....	14	43	.....	.....
31	16	11	.....	22	.....	22	14	.....	14	.....	.....	.....

NOTE.—Discharge determined from rating curve well defined below 350 million gallons per day. Gage height not recorded on days for which discharge is not given.

Monthly discharge of Waioli stream near Hanalei, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	53	11	25.0	38.7	776	2,380
August	53	11	19.2	29.7	594	1,830
September	16	8.0	10.7	16.6	322	985
October	78	9.5	23.8	36.8	738	2,260
December	310	11	42.7	66.1	1,320	4,060
January	226	7.0	36.8	56.9	1,140	3,500
February	32	8.0	11.6	17.9	324	997
March	86	8.0	27.3	42.2	845	2,600
April	43	9.5	16.3	25.2	490	1,500
May 1-26	179	14	36.8	56.9	956	2,930

WAINIHA RIVER (EAST AND WEST CHANNELS), NEAR WAINIHA, KAUAI.

LOCATION.—Just northeast of Kauai Electric Co.'s power house, 2 miles south of Wainiha.

RECORDS AVAILABLE.—East Channel, February 25, 1912, to December 18, 1916; West Channel, December 30, 1911, to December 18, 1916.

GAGE.—Inclined staff in each channel.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge over each channel.

Digitized by Google

CHANNEL AND CONTROL.—The river divides a short distance above power house and a station is maintained on each channel to obtain total flow. Fish dams built by the natives at the point where the river divides shift the water from one channel to the other. Control for east channel composed of boulders; fairly permanent; control for west channel composed of boulders; shifting.

EXTREMES OF DISCHARGE.—East channel: Maximum stage recorded during period of record, 15.0 feet December 18, 1916 (discharge, computed from extension of rating curve, approximately 3,000 million gallons per day, or 4,640 second-feet); minimum stage recorded, 6.5 feet August 3–6, 1913 (discharge, 3 million gallons per day, or 4.6 second-feet).

West channel: Maximum stage recorded during period of record, 9.0 feet at 5 p. m. September 26, 1914, and December 18, 1916 (discharge, 1,500 million gallons per day, or 2,320 second-feet); minimum stage recorded, 5.4 feet, frequently (discharge, 53 million gallons per day, or 82 second-feet).

DIVERSIONS.—Water diverted for power development above stations is returned to river again just above station on west channel.

REGULATION.—None except by diversions.

UTILIZATION.—Part of water passing stations is used for irrigation of rice and taro.

ACCURACY.—East channel: Records fair below 500 million gallons per day.

West channel: Records fair below 400 million gallons per day.

Gages read twice daily.

Discharge measurements of east channel of Wainiha River near Wainiha, Kauai, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 26	W. V. Hardy	7.55	59	38
Nov. 24	D. E. Horner	8.09	104	67

Daily discharge, in million gallons, of east channel of Wainiha River near Wainiha, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	236	37	42	42	42	137	16	270	48	37	48	42	164
2	73	92	55	37	37	120	17	345	73	42	48	42	55
3	92	106	42	32	382	79	18	174	164	55	42	420	.....
4	164	99	42	32	450	73	19	48	92	113	155	55	.....
5	48	48	42	59	214	73	20	85	113	52	55	55	.....
6	48	48	42	48	395	55	21	59	73	52	55	740	.....
7	40	155	92	42	510	184	22	48	48	155	55	146	.....
8	37	52	42	.....	282	73	23	40	42	63	48	73	.....
9	37	52	92	55	247	184	24	37	42	48	137	73	.....
10	37	45	55	48	73	73	25	37	42	85	358	79	.....
11	42	37	55	37	358	55	26	37	42	155	73	113	.....
12	42	37	42	32	48	73	27	55	42	73	55	73	.....
13	174	45	42	37	42	63	28	48	42	184	420	214	.....
14	155	128	42	42	42	55	29	37	42	55	120	258	.....
15	68	113	42	42	146	55	30	42	42	42	184	792	.....
							31	37	42	.....	73	.....	.....

NOTE.—Discharge determined from rating curve fairly well defined below 500 million gallons per day. Gage height not recorded Oct. 8.

Digitized by Google

Monthly discharge of east channel of Wainiha River near Wainiha, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	345	37	86.8	134	2,690	8,260
August	164	37	67.2	104	2,080	6,390
September	184	37	66.0	102	1,980	6,080
November	792	37	215	333	6,440	19,800
December 1–17	184	55	92.4	143	1,570	4,820

The following discharge measurement was made of the west channel of Wainiha River by W. V. Hardy:

July 26, 1916: Gage height, 5.48 feet; discharge, 65 million gallons per day, or 101 second-feet.

Daily discharge, in million gallons, of west channel of Wainiha River near Wainiha, Kauai, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	180	67	67	67	85	166	16	180	85	60	76	85	128
2	105	116	85	60	76	116	17	262	116	67	76	85	85
3	116	128	67	53	245	105	18	152	180	105	67	279	806
4	152	128	67	53	279	105	19	85	128	152	140	105	.....
5	85	85	67	95	152	105	20	116	140	85	95	105	.....
6	85	85	67	85	262	85	21	105	105	85	95	482	.....
7	67	140	116	67	386	140	22	95	85	166	95	152	.....
8	67	85	67	.....	245	105	23	67	67	95	85	105	.....
9	67	85	116	95	196	140	24	67	67	85	128	105	.....
10	67	76	85	76	105	105	25	67	67	128	279	105	.....
11	76	67	85	60	405	85	26	67	67	166	105	128	.....
12	76	67	67	53	85	105	27	95	67	105	85	105	.....
13	152	76	67	60	85	95	28	85	67	166	350	152	.....
14	140	152	67	67	85	85	29	67	67	85	128	196	.....
15	95	152	67	67	128	85	30	76	67	67	212	462	.....
							31	67	67	.....	105	.....	.....

NOTE.—Discharge determined from a rating curve well defined below 400 million gallons per day. Gage height not recorded Oct. 8.

Monthly discharge of west channel of Wainiha River near Wainiha, Kauai, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	262	67	103	159	3,180	9,800
August	180	67	95.2	147	2,950	9,060
September	166	60	92.5	143	2,770	8,520
November	482	76	182	282	5,470	16,800
December 1–18	806	85	147	227	2,650	8,130

Digitized by Google

Miscellaneous measurements on Kauai for the year ending June 30, 1917.

Date.	Stream.	Locality.	Gage height (feet).	Discharge.	
				Second-feet.	Million gallons per day.
July 26	Wainiha River	50 feet below diversion dam at intake of Kauai Electric Co.'s ditch.		9.4	6.1
Aug. 3	Tributary	Discharges into Anahola ditch 1.6 miles below intake.		3.0	1.9
3	do	Discharges into Anahola ditch 2.0 miles below intake.		1.1	.7
3	Anahola ditch	Intake, near Kealia		10.2	6.6
3	do	Flume, 1.6 miles below intake		10.2	6.6
3	do	2.5 miles below intake		11.6	7.5
Apr. 24	Opaikaa	One-fourth mile above falls, near Kapaa		13.9	9.0
Sept. 3	Mohihi	Elevation 3,300 feet, near Waimea	3.69	1.9	1.2
Dec. 9	do	do	4.14	13.4	8.6
Feb. 1	do	do	4.08	9.3	6.0
Apr. 3	do	do	4.12	11.3	7.3
Sept. 2	Waiakoali	Elevation 3,400 feet, near Waimea	1.26	1.3	8.5
Dec. 9	do	do	1.70	9.3	6.0
July 25	Wainiha Canal	Intake	4.10	79	51
Sept. 5	do	do	3.77	75	49
Oct. 22	do	do	4.72	89	57
23	do	do	4.70	91	59
28	do	do	4.83	90	58
29	do	do	4.85	90	58
Aug. 31	Kauaikanana	Elevation, 3,300 feet, near Waimea	.34	.9	.6
Dec. 5	do	do	.82	3.6	2.3
8	do	do	1.12	6.8	4.4
Nov. 6	Kaholalele ditch	About 1,500 feet below intake, near Lihue	1.29	4.5	2.9
Dec. 22	do	do	.96	1.8	1.2
23	do	do	.60	.75	.5
Jan. 19	do	do	1.15	3.8	2.5

ISLAND OF OAHU.

KALIHI STREAM NEAR HONOLULU, OAHU.

LOCATION.—At Kioi pool, about three-eighths mile above Catholic Orphanage, 3 miles up Kalihi road from King Street car line, and 5 miles north of Honolulu post office.

RECORDS AVAILABLE.—September 8, 1913, to June 30, 1917.

GAGE.—Gurley weight-driven water-stage recorder installed December 4, 1913. Friez recorder in use September 8 to November 22, 1913.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 500 feet above gage.

CHANNEL AND CONTROL.—Water drops over a 10-foot fall into pool at gage. Channel in solid rock, with steep, high banks; two channels at stage of 6.0 feet and over. The high-water control is solid rock, but gravelsometimes collects in the low-water control and affects the stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 12.5 feet at 1 a. m. March 19, 1917 (discharge, approximately 400 million gallons per day, or 619 second-feet); minimum stage recorded, 2.50 feet November 1, 1913 (discharge, 0.5 million gallons per day, or 0.8 second-feet).

Minimum stage recorded during year, 2.2 feet October, February, and March (discharge, 1.0 million gallons per day, or 1.55 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Part of water diverted 400 feet below station for power development; remaining low-water flow is diverted farther downstream for irrigation of taro.

ACCURACY.—Records good for all stages, as sufficient current-meter measurements were made to give well-defined curves covering the periods between changes in control.

Digitized by Google

Discharge measurements of Kalihi Stream near Honolulu, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Sept. 22	H. A. R. Austin	2.48	4.24	2.7
Nov. 29	do	2.74	8.74	5.6
Jan. 31	do	2.43	4.24	2.7
Mar. 13	do	3.06	11	7.1
Apr. 4	R. D. Klise	3.06	6.22	4.0
26	do	2.57	3.64	2.4
May 17	H. A. R. Austin	2.58	4.0	2.6
June 7	do	3.03	3.3	2.1
27	do	2.91	2.56	1.7

Daily discharge, in million gallons, of Kalihi Stream near Honolulu, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	1.9	3.0	2.2	1.6	3.0	3.5	4.6	2.2	1.0	4.6	7.0	4.6
2	1.9	7.6	3.0	1.6	2.6	39	4.0	2.2	1.0	4.6	4.6	3.0
3	4.6	4.0	1.9	1.6	2.2	7.6	5.8	2.2	1.3	4.0	8.3	3.0
4	4.0	6.4	1.9	1.3	9.7	21	4.6	1.9	2.6	3.5	9.0	2.6
5	2.6	3.0	1.6	1.3	8.3	7.6	8.3	1.9	1.6	5.8	3.5	2.6
6	1.9	3.5	1.6	5.2	7.6	10	4.0	2.6	1.9	3.5	3.0	2.6
7	1.9	5.8	2.2	1.9	7.6	21	3.5	1.9	1.3	3.0	2.6	2.2
8	1.6	4.6	1.6	1.6	4.0	8.3	3.0	1.6	1.0	3.0	2.2	2.2
9	1.6	4.0	1.6	4.0	3.5	6.4	4.0	1.6	23	5.8	2.2	5.2
10	1.6	3.5	1.6	1.9	7.6	6.4	54	1.6	3.5	3.0	2.2	2.6
11	1.9	2.6	1.3	1.3	5.2	4.6	6.4	1.3	10	11	2.2	2.6
12	1.9	2.6	2.2	1.3	3.0	4.6	4.0	1.3	58	5.2	1.9	2.2
13	1.9	2.2	1.9	1.3	3.0	6.4	3.5	4.6	11	3.5	1.9	1.9
14	1.6	5.8	1.3	1.0	2.6	4.6	3.0	3.5	32	3.0	4.6	1.9
15	1.6	5.2	1.3	1.6	5.8	4.0	2.6	1.9	22	3.0	2.2	7.0
16	5.8	4.0	1.6	1.3	3.0	3.5	7.0	1.6	9.7	4.6	1.9	13
17	18	4.0	1.6	1.3	16	11	6.4	1.6	9.0	3.5	1.9	3.0
18	4.0	3.0	1.3	2.2	38	16	3.0	2.6	8.3	3.0	17	4.0
19	3.0	3.5	1.6	2.6	5.8	17	14	1.6	68	2.6	21	2.6
20	2.6	3.0	1.3	1.9	4.0	6.4	14	1.6	68	2.6	5.8	2.2
21	2.6	3.5	1.6	1.6	3.5	5.2	5.2	1.3	13	3.5	3.5	2.2
22	2.2	2.6	1.9	1.3	3.0	4.6	4.0	1.3	8.3	3.5	3.0	2.2
23	1.9	2.2	1.3	3.5	3.0	12	3.5	1.3	7.0	7.6	3.0	1.9
24	1.9	3.5	2.2	1.9	3.0	10	9.0	1.0	8.3	3.5	2.6	1.9
25	1.9	2.2	2.2	2.2	3.0	4.6	3.5	1.0	15	2.2	2.2	1.9
26	1.9	2.2	5.8	1.9	9.0	4.0	19	1.0	10	2.2	2.6	1.6
27	2.2	2.2	5.2	5.8	3.0	16	4.6	1.0	6.4	1.9	2.2	1.6
28	2.2	2.2	3.0	24	10	26	3.5	1.0	5.8	18	4.6	1.6
29	1.9	1.9	2.2	10	6.4	16	3.0	.....	3.5	38	2.6	1.6
30	1.9	1.9	1.6	9.0	5.2	5.8	2.6	.....	5.2	10	10	1.6
31	3.0	2.2	.....	4.0	.....	4.6	2.6	.....	4.6	.....	9.7	.....

NOTE.—Discharge determined from well-defined rating curves applicable; July 1 to Mar. 12, Mar. 13-20, Mar. 21 to Apr. 26, Apr. 27 to May 19, and May 20 to June 30.

Digitized by Google

Monthly discharge of Kaliki Stream near Honolulu, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	18	1.6	2.89	4.47	90	275
August	7.6	1.9	3.48	5.38	108	331
September	5.8	1.3	2.05	3.17	62	189
October	24	1.0	3.32	5.14	103	316
November	38	2.2	6.39	9.89	192	588
December	39	3.5	10.2	15.8	318	970
January	54	2.6	7.10	11.0	220	675
February	4.6	1.0	1.79	2.77	50	154
March	68	1.0	13.6	21.0	421	1,290
April	38	1.9	5.77	8.93	173	531
May	21	1.9	4.87	7.54	151	463
June	13	1.6	2.97	4.60	89	273
The year	68	1.0	5.41	8.37	1,980	6,060

NUUANU STREAM BELOW RESERVOIR NO. 2 WASTEWAY, NEAR HONOLULU, OAHU.

LOCATION.—On Pali road in upper Nuuanu Valley, 1 mile above end of car line and 5 miles from Honolulu post office.

RECORDS AVAILABLE.—October 21, 1913, to June 30, 1917.

GAGE.—Inclined staff on right bank.

DISCHARGE MEASUREMENTS.—Low-water discharge measured by 2-foot sharp-crested weir with end contractions; flood discharge measured by 12-foot sharp-crested weir with end contractions, which, with small weir, gives total flood discharge. Both weirs set in concrete. Crest of small weir is 1 foot lower than that of large weir. The weirs were reconstructed April 10–27, 1914, but original dimensions were maintained.

CHANNEL AND CONTROL.—Channel in solid rock; straight for about 75 feet above and below weir; banks high and covered with vegetation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 6.0 feet at 4 p. m. April 5, 1914 (no estimate of discharge possible, as entire weir was overflowed); minimum stage recorded, 0.10 foot in November. 1913, September, 1915, July and August, 1916 (discharge, 0.15 million gallon per day, or 0.25 second-foot).

DIVERSIONS.—Most of the flow at low and medium stages is diverted above station for domestic supply and for power development. An irrigation ditch diverts low-water discharge at point 300 feet below station.

REGULATION.—Amount diverted above station varies.

UTILIZATION.—Station measures the waste water and seepage from reservoirs Nos. 2, 3, and 4, and the Luakaha weir. This waste water is used for irrigation of taro and rice.

ACCURACY.—Records good below 4 million gallons per day, but only fair for larger flow owing to varying velocity of approach and uncertainties resulting from use of compound weir.

40532°—18—WSP 465——6

Digitized by Google

Daily discharge, in million gallons, of Nuuanu Stream below reservoir No. 2 wasteway, near Honolulu, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	1.1	3.4	1.3	0.9	4.0	3.4	5.6	4.3	2.0	7.6	20	10
2	1.1	11	1.1	.75	1.8	28	5.6	4.3	1.8	7.6	18	5.6
3	2.3	4.0	1.1	.75	1.5	4.3	4.0	4.3	4.3	7.6	11	5.6
4	3.7	6.5	1.1	.75	4.3	34	6.5	4.3	4.3	7.6	7.6	6.5
5	3.4	3.4	1.1	.55	15	2.5	5.6	4.3	3.7	10	8.9	7.6
6	1.8	3.4	1.1	1.1	4.8	2.0	5.6	4.3	3.4	8.9	10	7.6
7	1.3	3.7	2.0	.9	3.7	18	4.8	4.3	2.5	7.6	8.9	5.6
8	1.1	3.4	.4	.75	4.0	5.6	3.7	4.3	2.0	6.5	7.6	24
9	1.1	3.4	.4	.75	3.4	4.8	3.7	4.3	5.6	7.6	6.5	15
10	.9	4.0	.4	.75	5.6	2.0	62	4.3	3.7	6.5	6.5	11
11	.55	3.4	.4	.55	3.7	1.8	6.5	4.3	3.1	28	5.6	8.9
12	.15	1.3	.4	.55	1.8	2.3	6.5	6.5	18	10	5.6	7.6
13	.4	.15	.4	.55	1.5	2.0	6.5	7.6	7.6	7.6	5.6	6.5
14	.4	1.5	.4	.55	1.5	4.0	6.5	4.3	32	7.6	16	8.9
15	.4	4.0	.4	.9	1.5	3.7	5.6	4.3	13	15	7.6	6.5
16	4.0	3.1	.4	.9	.....	3.7	4.8	4.0	8.9	16	5.6	16
17	4.8	3.7	.4	.9	6.5	4.3	4.8	4.0	6.5	10	5.6	10
18	2.8	3.1	.4	1.8	32	26	4.8	4.0	10	5.6	16	15
19	1.1	2.5	.4	1.3	4.0	26	4.8	3.1	.....	5.6	.....	6.5
20	1.5	2.3	.4	.9	3.1	5.6	32	2.8	26	5.6	13	5.6
21	1.3	2.0	.55	.75	3.1	4.8	7.6	2.8	8.9	4.8	8.9	4.8
22	1.3	.75	.55	.75	2.8	5.6	5.6	2.8	15	15	7.6	4.3
23	1.1	.9	.55	1.1	2.5	7.6	4.8	2.5	18	6.5	5.6	4.3
24	1.3	.75	.55	1.1	2.5	10	4.8	2.5	24	6.5	5.6	4.3
25	1.3	.9	.9	1.1	2.3	5.6	5.6	2.0	37	4.8	5.6	4.3
26	1.3	.9	7.6	.4	3.4	4.8	28	2.0	28	4.8	5.6	4.3
27	2.0	1.1	4.3	3.7	3.1	22	5.6	2.0	18	4.8	4.8	4.3
28	1.1	1.1	.9	24	20	32	6.5	2.0	11	34	4.3	4.3
29	1.3	1.3	.9	16	22	13	4.8	.....	10	104	4.8	4.0
30	2.5	1.3	.75	6.5	5.6	8.9	4.8	.....	8.9	22	48	4.0
31	3.4	1.5	.....	4.0	.....	6.5	.....	.....	7.6	.....	30	.....

NOTE.—Weir undergoing repairs Nov. 16; gage height not recorded Mar. 19 and May 19.

Monthly discharge of Nuuanu Stream below reservoir No. 2 wasteway, near Honolulu, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	4.8	0.15	1.67	2.58	52	159
August	11	.15	2.70	4.18	84	257
September	7.6	.4	1.05	1.62	32	97
October	24	.4	2.46	3.81	76	234
December	34	1.8	9.83	15.2	305	935
January 1-30	62	3.7	8.93	13.8	268	822
February	7.6	2.0	3.80	5.88	106	327
April	104	4.8	13.2	20.4	396	1,220
June	24	4.0	7.76	12.0	233	714

Digitized by Google

MANOA STREAM AT COLLEGE OF KAWAII, NEAR HONOLULU, OAHU.

LOCATION.—In gorge about half a mile southeast of College of Hawaii and 3 miles east of Honolulu post office.

RECORDS AVAILABLE.—March 23, 1909, to November 24, 1910; November 1, 1912, to April 26, 1913; September 10, 1913, to June 30, 1917.

GAGE.—Vertical staff on left bank. The weir used during 1909 and 1910 was destroyed by flood of November 24, 1910. Several changes in gage datum previous to 1912.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Channel straight and confined in the vicinity of station; stream bed composed of rock; clean and fairly permanent; left bank composed of rock nearly vertical; right bank slopes gently and is covered with vegetation.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 6.1 feet from high-water mark of flood March 19, 1917 (discharge, from extension of rating curve, 260 million gallons per day, or 402 second-feet); minimum daily discharge, March, 1914 (0.2 million gallons per day, or 0.3 second-foot).

Minimum stage recorded during year, 0.7 foot June 28–30 (discharge, 0.8 million gallons per day, or 1.2 second-feet).

DIVERSIONS.—Nearly all the low water flow is diverted above and below the station for irrigation.

REGULATION.—None.

UTILIZATION.—Records show water available for storage at this reservoir site; the low-water flow of the stream is extensively used for irrigation of rice and taro in upper and lower Manoa Valley.

ACCURACY.—Gage read twice daily. Records good for low and medium stages, but may be considerably in error for high and fluctuating stages.

COOPERATION.—Gage-height record furnished by College of Hawaii.

Discharge measurements of Manoa Stream at College of Hawaii, near Honolulu, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 29	H. A. R. Austin	1.28	5.35	3.5
Jan. 11	do	1.78	15.3	9.9
Mar. 8	College of Hawaii	.96	2.10	1.4
23	do	1.70	21.9	14
Apr. 30	H. A. R. Austin	1.74	18.5	12
May 14	do	1.85	22.1	14
14	do	1.72	17.4	11
June 30	do	.71	1.2	.8

Digitized by Google

Daily discharge, in million gallons, of Manoa Stream at College of Hawaii, near Honolulu, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	7.4	15	5.8	4.6	4.1	24	8.3	5.2	2.6	6.0	10	8.4
2	5.8	20	13	4.6	4.6	36	8.3	4.1	2.2	6.0	10	3.4
3	8.3	20	5.2	2.6	4.6	23	9.2	3.6	2.6	5.3	12	3.4
4	17	56	4.1	1.8	18	58	7.4	3.1	3.1	5.3	9.2	4.0
5	7.4	26	2.6	3.6	17	18	7.4	2.6	2.6	5.3	7.6	3.4
6	7.4	17	3.6	3.1	23	20	6.6	1.8	2.6	4.6	7.6	4.6
7	5.8	13	13	3.6	12	23	4.6	1.5	2.6	4.6	6.8	4.0
8	5.2	8.3	3.6	2.6	11	17	3.1	2.6	6.6	4.6	4.6	3.4
9	4.6	7.4	4.6	2.6	13	15	2.6	2.2	2.2	4.6	1.6	4.0
10	4.1	11	3.6	2.6	11	17	78	1.8	1.8	4.0	1.6	3.4
11	4.6	11	2.6	2.6	10	13	15	1.8	1.8	26	1.6	4.6
12	4.6	5.2	2.6	2.2	8.3	8.3	7.4	2.6	16	21	2.4	4.6
13	10	5.8	3.6	1.8	6.6	10	5.8	2.6	11	15	4.0	4.6
14	6.6	32	3.1	1.5	5.8	11	4.1	3.1	20	10	2.9	4.6
15	5.8	20	2.6	1.5	6.6	7.4	3.1	3.1	23	7.6	2.0	4.0
16	50	13	2.6	1.5	9.2	7.4	32	1.8	16	4.0	1.6	3.4
17	20	12	2.6	2.6	5.2	32	23	2.6	15	3.4	4.6	3.4
18	23	13	3.1	3.6	7.4	42	13	2.6	38	2.9	7.6	3.4
19	36	17	6.6	6.6	26	28	13	15	101	3.4	6.0	2.9
20	8.3	16	5.2	5.2	10	22	34	8.3	57	3.4	8.4	2.9
21	5.8	23	4.6	4.1	11	16	17	4.6	33	4.0	7.6	2.4
22	5.8	10	7.4	4.1	8.3	32	11	3.1	15	6.8	5.3	1.4
23	5.2	7.4	4.6	3.6	5.8	23	8.3	2.6	13	7.6	4.6	1.4
24	4.6	6.6	5.2	3.1	4.6	16	5.2	2.6	12	10	4.6	1.1
25	4.6	5.8	7.4	9.2	5.8	11	2.6	2.2	11	9.2	3.4	1.0
26	5.2	5.8	24	4.6	5.8	8.3	23	1.8	20	7.6	3.4	1.0
27	4.6	5.2	11	4.6	4.6	40	22	1.8	15	7.6	3.4	.9
28	4.1	5.2	7.4	20	13	82	12	1.8	18	6.8	3.4	.8
29	4.6	5.2	5.2	8.3	6.6	13	8.3	.....	22	6.0	3.4	.8
30	4.6	7.4	3.6	23	5.8	11	6.6	.....	10	6.0	13	.8
31	32	4.6	.....	6.6	.....	9.2	5.8	.....	7.6	.....	15	.....

NOTE.—Discharge determined from rating curves well defined below 20 million gallons per day, applicable: July 1 to Mar. 19 and Mar. 20 to June 30.

Monthly discharge of Manoa Stream at College of Hawaii, near Honolulu, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	50	4.1	10.4	16.1	323	989
August	56	4.6	13.7	21.2	425	1,300
September	24	2.6	5.80	8.97	174	534
October	23	1.5	4.90	7.58	152	466
November	26	4.1	9.49	14.7	285	874
December	82	7.4	22.4	34.7	694	2,130
January	78	2.6	13.2	20.4	408	1,260
February	15	1.5	3.30	5.11	92	284
March	101	1.8	16.3	25.2	504	1,550
April	26	2.9	7.29	11.3	219	671
May	15	1.6	5.78	8.94	179	550
June	8.4	.8	3.07	4.75	92	283
The year	101	.8	9.72	15.0	3,550	10,900

Digitized by Google

WEST BRANCH OF MANOA STREAM NEAR HONOLULU, OAHU.

LOCATION.—At diversion dam at R. W. Shingle's bungalow, 300 feet above highway bridge, about one-eighth mile above confluence with East Branch of Manoa stream, 4 miles northeast of Honolulu post office.

RECORDS AVAILABLE.—May 29, 1913, to June 30, 1917.

GAGE.—Watson water-stage recorder in use June 17 to October 20, 1914; replaced October 20, 1914, by a Friez water-stage recorder, which was replaced May 9, 1915, by a Stevens 8-day water-stage recorder; all at same site and datum. Vertical staff gage (at different datum) 150 feet upstream from highway bridge, about 25 feet above a small irrigation ditch diverting from right bank, read from May 29, 1913, to June 16, 1914.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Small masonry diversion dam with wide, rounded crest acts as control and forms a large, quiet pool in the vicinity of the gage for low and medium stages. Leaves and small débris lodge on control and growth of grass on sides at times affects the stage-discharge relation slightly. Channel clean and stream confined in the vicinity of the gage. A short distance upstream the natural slope is steep and the channel is filled with boulders.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 4.65 feet 12.15 a. m. March 20, 1917 (discharge, 200 million gallons per day, or 309 second-feet); minimum stage recorded, December, 1913 (discharge, 0.05 million gallons per day, or 0.08 second-foot).

Minimum stage recorded during year, 1.0 foot August 12 and 25–27 (discharge, 0.3 million gallons per day, or 0.46 second-foot).

DIVERSIONS.—None above station.

REGULATION.—At low water pool at gage is lowered slightly for short periods by the operation of a small hydraulic ram used for pumping water for domestic use and also for filling a swimming pool.

UTILIZATION.—Records on West and East Branches of Manoa stream together show amount of surface water available in upper Manoa Valley above nearly all diversions. Practically the entire low water flow of Manoa stream is utilized at lower elevations in Manoa Valley for rice and taro irrigation.

ACCURACY.—Records good except for extreme low-water periods, when regulation at control and lack of sensitiveness of control section prevented refined accuracy of low-water estimates.

Discharge measurements of West Branch of Manoa Stream near Honolulu, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 29	H. A. R. Austin	1.09	1.75	1.1
Jan. 10	do	1.51	17.8	11
Mar. 14	R. C. Rice	1.28	7.99	5.2
Apr. 30	H. A. R. Austin	1.19	5.23	3.4

Digitized by Google

Daily discharge, in million gallons, of West Branch of Manoa Stream near Honolulu, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.3	3.2	1.4	1.4	1.4	5.6	3.2	1.4	1.4	3.2	5.6	3.2
2	1.4	6.9	3.2	1.4	1.4	19	3.2	.6	1.4	3.2	4.4	1.4
3	5.6	2.3	1.4	1.4	1.4	14	3.2	.6	2.3	3.2	2.3	1.4
4	2.3	4.4	.6	1.4	6.9	12	4.4	.6	3.2	2.3	2.3	1.4
5	1.4	.6	.6	1.4	6.9	5.6	5.6	.6	2.3	3.2	2.3	1.4
6	1.4	1.4	.6	3.2	6.9	4.4	2.3	1.4	2.3	2.3	1.4	3.2
7	.6	1.4	3.2	2.3	4.4	6.9	1.4	1.4	2.3	1.4	2.3	2.3
8	.6	.6	1.4	1.4	5.6	4.4	1.4	1.4	1.4	1.4	1.4	4.4
9	.6	.6	1.4	2.3	4.4	3.2	1.4	.6	1.4	2.3	1.4	12
10	.6	1.4	.6	1.4	4.4	3.2	11	.6	1.4	1.4	1.4	3.2
11	.6	.6	.6	1.4	5.6	2.3	3.2	.6	4.4	8.2	1.4	5.6
12	1.4	.3	2.3	1.4	3.2	2.3	2.3	.6	8.2	3.2	1.4	2.3
13	2.3	.6	1.4	1.4	3.2	3.2	2.3	2.3	4.4	2.3	1.4	1.4
14	1.4	5.6	.6	1.4	3.2	2.3	1.4	1.4	9.6	2.3	4.4	2.3
15	1.4	5.6	.6	1.4	4.4	2.3	1.4	.6	6.9	1.4	2.3	2.3
16	6.9	1.4	.6	1.4	3.2	2.3	2.3	.6	4.4	2.3	1.4	1.4
17	8.2	3.2	.6	1.4	11	5.6	2.3	.6	3.2	2.3	2.3	1.4
18	3.2	1.4	.6	1.4	11	9.6	1.4	1.4	2.3	1.4	5.6	2.3
19	2.3	2.3	3.2	1.4	4.4	14	4.3	1.4	14	1.4	11	1.4
20	1.4	2.3	.6	1.4	3.2	5.6	6.9	1.4	21	1.4	5.6	.6
21	1.4	2.3	1.4	1.4	3.2	3.2	2.3	.6	5.6	1.4	3.2	.6
22	1.4	.6	1.4	1.4	3.2	4.4	2.3	.6	3.2	5.6	2.3	.6
23	.6	.6	1.4	2.3	3.2	4.4	2.3	.6	3.2	6.9	3.2	.6
24	.6	.6	1.4	3.2	3.2	8.2	2.3	.6	3.2	3.2	2.3	.6
25	1.4	.3	2.3	2.3	17	3.2	2.3	.6	6.9	2.3	2.3	.6
26	.6	.3	6.9	3.2	8.2	3.2	12	.6	5.6	1.4	2.3	.6
27	1.4	.3	4.4	6.9	4.4	11	3.2	.6	3.2	1.4	2.3	.6
28	1.4	.6	2.3	6.9	9.6	11	1.4	.6	4.4	5.6	2.3	1.4
29	.6	1.4	2.3	5.6	6.9	8.2	1.4	.....	6.9	9.6	2.3	1.4
30	2.3	1.4	1.4	4.4	4.4	4.4	1.4	.....	3.2	3.2	6.9	1.4
31	4.4	2.3	.....	2.3	.....	4.4	1.4	.....	3.2	.....	5.6	.....

NOTE.—Discharge determined from rating curve well defined below 20 million gallons. Discharge Sept. 9–10 and Oct. 15–21 determined by comparison with records of flow of East Branch.

Monthly discharge of West Branch of Manoa Stream near Honolulu, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	8.2	0.6	2.00	3.09	62	190
August	6.9	.3	1.83	2.83	57	174
September	6.9	.6	1.69	2.61	51	156
October	6.9	1.4	2.31	3.57	72	220
November	17	1.4	5.31	8.22	159	489
December	19	2.3	6.24	9.65	193	594
January	12	1.4	3.14	4.86	97	299
February	2.3	.6	.89	1.38	25	76
March	21	1.4	4.72	7.30	146	449
April	9.6	1.4	3.02	4.67	91	278
May	11	1.4	3.12	4.83	97	297
June	12	.6	2.11	3.26	63	194
The year	21	.3	3.05	4.72	1,110	3,420

Digitized by Google

EAST BRANCH OF MANOA STREAM NEAR HONOLULU, OAHU.

LOCATION.—At highway bridge 400 feet above confluence with West Branch of Manoa stream, in upper Manoa Valley, and 4 miles northeast of Honolulu post office From May 29, 1913, to May 19, 1914, station was 200 feet upstream from bridge.

RECORDS AVAILABLE.—May 29, 1913, to June 30, 1917.

GAGE.—Stevens 8-day water-stage recorder. Watson water-stage recorder from May 29, 1913, to September 28, 1914. Vertical staff gage 200 feet upstream on right bank at different datum was read from May 29, 1913, to May 19, 1914.

DISCHARGE MEASUREMENTS.—Made by wading for low and ordinary high-water stages; flood measurements may be made from highway bridge.

CHANNEL AND CONTROL.—Channel steep just above gage, but slope is reduced for 30 feet past gage to control, which is a riffle of small boulders and gravel, and control shifts considerably. At low and medium stages stream past gage is fairly wide and deep and velocity is well distributed. Banks are fairly steep and covered with vegetation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.2 feet at 4 p. m. March 19, 1917 (discharge, from extension of rating curve, 400 million gallons per day, or 619 second-feet); minimum daily discharge, March, 1914, 0.9 million gallons per day, or 1.4 second-feet.

Minimum stage recorded during year, 1.3 feet March 5–9 (discharge, 1 million gallons per day, or 1.55 second-feet).

DIVERSIONS.—East Manoa ditch diverts a quarter of a mile above station for irrigation.

REGULATION.—None.

UTILIZATION.—Records on East and West branches of Manoa stream together show amount of surface water available in upper Manoa Valley above nearly all diversions. Practically the entire low-water flow of Manoa stream is utilized at lower elevations in Manoa Valley for irrigation of rice and taro.

ACCURACY.—Rating curves well defined. Gage-height record continuous. Records good for all stages.

Discharge measurements of East Branch of Manoa Stream near Honolulu, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 13	H. A. R. Austin	1.54	5.22	3.4
Aug. 29	do	1.43	3.16	2.0
Sept. 29	do	1.50	4.50	2.9
Dec. 4	do	1.75	10.1	6.5
Jan. 10	do	2.32	41	26
Feb. 23	do	1.38	2.45	1.6
Mar. 14	R. C. Rice	1.54	5.29	3.4
19	do	1.99	17.2	11
May 14	H. A. R. Austin	1.71	8.0	5.2
June 13	do	1.53	3.96	2.6
21	do	1.47	2.67	1.7

Digitized by Google

Daily discharge, in million gallons, of East Branch of Manoa Stream near Honolulu, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.4	4.5	2.4	3.0	2.4	3.0	2.4	2.4	1.4	3.5	5.0	2.8
2	2.4	6.2	3.8	2.4	2.4	15	2.4	1.8	1.4	3.5	5.9	2.2
3	9.4	4.5	1.8	2.4	2.4	14	2.4	1.8	1.4	3.5	4.2	2.2
4	5.4	8.2	1.8	1.8	5.4	14	2.4	1.4	1.4	2.8	3.5	2.2
5	3.8	4.5	1.8	1.8	3.8	5.4	3.0	1.4	1.0	2.8	3.5	2.2
6	3.0	7.2	1.8	2.4	3.8	4.5	2.4	1.4	1.0	2.8	3.5	2.8
7	3.0	4.5	3.0	1.8	3.0	6.2	1.8	1.4	1.0	2.2	3.5	2.8
8	3.0	3.8	1.8	1.8	3.0	3.8	1.8	1.4	1.0	2.2	2.8	4.2
9	2.4	3.8	1.8	2.4	2.4	3.0	1.8	1.4	1.0	2.8	2.8	5.9
10	2.4	3.8	1.4	1.8	2.4	3.0	17	1.4	1.4	2.2	2.2	2.8
11	3.0	3.8	1.4	1.8	3.0	3.0	3.8	1.4	3.0	6.8	2.2	4.2
12	2.4	3.0	2.4	1.8	2.4	3.0	3.0	1.4	3.0	3.5	2.2	2.8
13	3.0	3.0	1.4	1.8	2.4	4.5	2.4	3.0	3.0	2.8	2.2	2.8
14	2.4	8.2	1.4	1.8	2.4	3.0	2.4	1.8	6.2	2.2	3.5	2.2
15	2.4	9.4	1.4	1.8	3.0	3.0	2.4	1.4	5.4	1.7	2.2	2.2
16	7.2	4.5	1.4	1.8	2.4	2.4	3.0	1.4	3.8	1.7	2.2	2.2
17	8.2	5.4	1.4	2.4	6.2	4.5	2.4	1.4	3.0	1.7	2.2	2.2
18	4.5	3.8	1.4	2.4	8.2	6.2	1.8	1.8	3.0	1.7	3.5	2.2
19	4.5	5.4	2.4	2.4	3.0	8.2	3.0	1.8	15	1.7	5.0	2.2
20	3.8	4.5	1.4	2.4	2.4	3.8	6.2	1.8	14	1.2	2.8	1.7
21	3.8	6.2	1.8	2.4	2.4	3.0	3.0	1.8	5.0	1.7	2.2	1.7
22	3.0	3.8	2.4	2.4	1.8	3.8	1.8	1.4	3.5	3.5	2.2	1.7
23	2.4	3.8	1.4	2.4	1.8	3.8	1.8	1.4	3.5	3.5	2.2	1.7
24	2.4	3.8	1.4	3.0	1.8	5.4	2.4	1.4	3.5	2.2	2.2	1.7
25	3.0	3.0	1.8	2.4	1.8	3.0	1.8	1.4	5.0	1.7	2.2	1.7
26	3.0	3.0	5.4	2.4	4.5	2.4	14	1.4	4.2	1.7	2.2	1.7
27	3.0	3.0	3.8	4.5	2.4	5.4	4.5	1.4	3.5	1.7	1.7	1.7
28	3.8	3.0	3.8	5.4	6.2	9.4	3.0	1.4	4.2	5.9	2.2	1.7
29	3.0	2.4	3.0	3.0	3.0	5.4	3.0	.....	5.0	11	2.2	1.7
30	3.0	2.4	3.0	2.4	3.0	3.0	2.4	.....	3.5	3.5	5.0	1.7
31	6.2	3.0	.....	2.4	.....	3.0	2.4	.....	4.2	.....	3.5	.....

NOTE.—Discharge determined from well-defined rating curves applicable July 1 to Mar. 19 and Mar. 20 to June 30. Discharge Jan. 7–13 determined by comparison with records of flow of West Branch.

Monthly discharge of East Branch of Manoa Stream near Honolulu, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	9.4	2.4	3.72	5.76	115	354
August	9.4	2.4	4.50	6.96	139	428
September	5.4	1.4	2.17	3.36	65	200
October	5.4	1.8	2.41	3.73	75	229
November	8.2	1.8	3.17	4.90	95	292
December	15	2.4	5.20	8.05	161	495
January	17	1.8	3.48	5.38	108	331
February	3.0	1.4	1.59	2.46	45	137
March	15	1.0	3.76	5.82	116	358
April	11	1.2	2.99	4.63	90	275
May	5.9	1.7	2.99	4.63	93	284
June	5.9	1.7	2.39	3.70	72	220
The year	17	1.0	3.22	4.98	1,170	3.600

Digitized by Google

MAKAWAO SPRING NEAR KAILUA, OAHU.

LOCATION.—Fifteen feet above flume joining Makawao ditch, three-fourths of a mile south of Maunawili ranch, and about 3 miles south of Kailua.

RECORDS AVAILABLE.—February 12, 1914, to November 30, 1916.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by a 1-foot sharp-crested wier with end contractions.

CHANNEL AND CONTROL.—Water emerges from ground directly into pool back of weir.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, January 1-31, 1916 (discharge, 0.5 million gallons per day, or 0.77 second-foot); minimum stage recorded, 0.29 foot frequently (discharge, 0.32 million gallons per day, or 0.50 second-foot).

DIVERSIONS.—None.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane by Waimanalo Sugar Co.

ACCURACY.—Gage read once daily. Flow steady and conditions at weir good. Records good.

Monthly discharge of Makawao Spring near Kailua, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	0.35	0.32	0.33	0.51	10	31
August	.34	.34	.34	.53	11	32
September	.34	.34	.34	.53	10	31
October	.32	.32	.32	.50	10	30
November	.32	.32	.32	.50	10	29
The period					51	153

MAIN SPRING NEAR KAILUA, OAHU.

LOCATION.—At head of Makawao ditch, 1 mile south of Maunawili ranch, and about 3 miles south of Kailua.

RECORDS AVAILABLE.—February 12, 1914, to November 30, 1916.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by a 1-foot sharp-crested wier with end contractions.

CHANNEL AND CONTROL.—Water emerges from ground directly into pool back of weir.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 0.60 foot January 1-31, 1916 (discharge, 0.88 million gallons per day, or 1.36 second-feet); minimum stage recorded, 0.39 foot March 17-28, 1914 (discharge, 0.48 million gallons per day, or 0.74 second-foot).

DIVERSIONS.—None.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane by Waimanalo Sugar Co.

ACCURACY.—Gage read once daily. Records fair. There is a small amount of seepage around weir and a velocity of approach of about 0.4 foot per second.

Digitized by Google

Monthly discharge of main spring near Kailua, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	0.78	0.70	0.74	1.14	23	70
August	.72	.67	.69	1.07	21	66
September	.67	.67	.67	1.04	20	62
October	.63	.63	.63	.97	20	60
November	.63	.63	.63	.97	19	58
The period					103	316

HAIKU STREAM NEAR HEEIA, OAHU.

LOCATION.—Sixty feet above intake of reservoir ditch, 1½ miles west of Heeia.

RECORDS AVAILABLE.—January 29, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder installed April 28, 1914, at same location and datum as staff gage; original staff-gage datum was raised 0.88 foot March 29, 1914.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 20 feet above and 40 feet below station; banks steep and high; stream bed of solid rock. Control is smooth, solid-rock ledge; permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 6.5 feet at 1 a. m. March 20, 1917 (estimated discharge, 250 million gallons per day, or 390 second-feet); minimum stage recorded, 0.6 foot July 16, 1916, and February 9–12, 1917 (discharge, 1.4 million gallons per day, or 2.2 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Low flow diverted below station for domestic supply and for irrigation of taro and rice.

ACCURACY.—Rating curves are well defined for low and medium stages; records good. High-water extension of rating curve not based on measurements, and determinations above 16 million gallons per day may be considerably in error.

Discharge measurements of Haiku Stream near Heeia, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Mar. 2	H. A. R. Austin	0.69	2.80	18
Apr. 30	do	.81	5.14	3.3

Digitized by Google

Daily discharge, in million gallons, of Haiku Stream near Heeia, Oahu, for the year ending June 30, 1917.

Date.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	3.0	2.4	3.0	2.4	2.4	2.4	2.4	2.4	2.1	2.1	2.6	2.1
2	3.0	3.0	3.0	2.4	2.4	5.0	2.4	2.4	2.1	2.1	3.9	2.1
3	3.0	3.0	3.0	2.4	2.4	5.7	2.4	2.4	2.1	2.1	2.6	2.1
4	3.0	3.0	3.0	2.4	3.6	5.7	2.4	2.4	2.1	2.1	2.6	2.1
5	3.0	2.4	3.0	2.4	3.0	3.0	2.4	1.9	2.1	2.1	2.6	2.6
6	2.4	3.0	2.4	2.4	2.4	3.0	2.4	3.0	2.1	2.1	2.1	2.1
7	2.4	3.0	2.4	2.4	3.0	6.4	2.4	1.9	2.1	2.1	2.1	2.1
8	2.4	3.0	2.4	2.4	2.4	3.0	2.4	1.9	2.1	2.1	2.1	2.1
9	3.0	2.4	2.4	2.4	2.4	3.0	3.0	1.4	11	2.1	2.1	2.1
10	2.4	2.4	2.4	2.4	2.4	2.4	14	1.4	5.3	2.1	2.6	2.1
11	3.0	2.4	2.4	2.4	2.4	2.4	3.6	1.4	2.1	3.2	2.6	2.1
12	2.4	2.4	2.4	1.9	2.4	2.4	2.4	1.4	22	2.1	2.6	2.1
13	2.4	2.4	2.4	1.9	2.4	2.4	2.4	3.0	3.9	2.1	2.6	2.1
14	1.9	3.0	2.4	1.9	2.4	2.4	2.4	2.4	7.6	2.1	3.2	2.6
15	1.9	3.0	3.0	1.9	3.0	2.4	2.4	1.9	3.2	2.1	3.2	3.2
16	1.4	3.0	3.0	1.9	2.4	2.4	3.6	1.9	4.6	2.1	3.2	2.6
17	4.3	3.0	3.0	1.9	3.0	3.0	3.0	1.9	3.2	2.1	3.2	2.6
18	3.0	3.0	3.0	2.4	7.8	3.6	2.4	3.6	3.2	2.1	4.6	2.6
19	3.0	3.0	2.4	2.4	3.0	3.0	6.4	2.4	26	2.1	11	2.6
20	3.0	3.0	3.0	2.4	3.0	3.0	5.7	2.4	16	2.1	3.9	2.6
21	3.0	3.0	3.0	2.4	2.4	2.4	3.0	2.4	3.9	2.1	3.2	2.6
22	3.0	3.0	2.4	1.9	2.4	2.4	3.0	2.4	3.2	2.1	3.2	2.6
23	2.4	3.0	2.4	2.4	2.4	2.4	2.4	2.4	2.6	2.1	3.2	2.6
24	3.0	4.3	2.4	2.4	2.4	3.6	2.4	3.0	2.6	2.6	3.2	2.6
25	3.0	3.6	2.4	2.4	2.4	3.0	2.4	8.0	3.2	2.1	2.6	2.6
26	3.0	3.6	3.6	2.4	3.0	2.4	5.7	3.0	2.6	2.1	2.6	2.6
27	2.4	3.6	3.0	2.4	2.4	3.0	3.0	3.0	2.1	2.1	2.6	2.6
28	2.4	3.6	2.4	3.6	3.0	7.1	3.0	2.4	2.1	6.0	2.1	2.6
29	2.4	3.6	2.4	3.0	3.0	3.6	3.0	.....	2.1	7.6	2.1	2.6
30	2.4	3.6	2.4	2.4	2.4	3.0	3.0	.....	2.1	3.2	27	2.6
31	2.4	3.0	.....	2.4	.....	3.0	2.4	.....	2.1	.....	5.3	.....

NOTE.—Discharge determined from rating curves well defined below 16 million gallons per day, applicable July 1 to Feb. 28 and Mar. 1 to June 30.

Monthly discharge of Haiku Stream near Heeia, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	4.3	1.4	2.69	4.16	83	256
August	4.3	2.4	3.02	4.67	94	287
September	3.6	2.4	2.68	4.15	80	247
October	3.6	1.9	2.35	3.64	73	224
November	7.8	2.4	2.80	4.33	84	258
December	7.1	2.4	3.31	5.12	102	315
January	14	2.4	3.35	5.18	104	319
February	3.6	1.4	2.32	3.59	65	199
March	26	2.1	4.95	7.66	154	471
April	7.6	2.1	2.50	3.87	75	230
May	27	2.1	3.95	6.11	122	376
June	3.2	2.1	2.42	3.74	73	223
The year	27	1.4	3.04	4.70	1,110	3,400

KAHANA STREAM NEAR KAHANA, OAHU.

LOCATION.—Half a mile above confluence with East Branch of Kahana stream, 1½ miles above mouth of stream, and south of Kahana.

RECORDS AVAILABLE.—June 19, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

Digitized by Google

CHANNEL AND CONTROL.—One channel at all stages; straight for 50 feet above and 150 feet below gage; stream bed of gravel and boulders; right bank steep and high; left bank slopes gently. Control composed of large and small boulders; shifts during floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 7.5 feet at 3 a. m. March 9, 1917 (discharge, approximately 1,400 million gallons per day, or 2,170 second-feet); minimum stage recorded, 0.8 foot September 4–11, 1916 (discharge, 11 million gallons per day, or 17 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane, taro, and rice.

ACCURACY.—Owing to instability of control, good rating curves were not developed. Records fair for low and medium stages.

Discharge measurements of Kahana Stream near Kahana, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Sept. 26	H. A. R. Austin	1.15	33.8	22
Nov. 8	do	1.04	25.0	16
Dec. 7	do	3.40	347	224
Mar. 6	do	.78	18.8	12
Apr. 10	do	.86	24	16
May 9	R. D. Klise	.95	24	16

Daily discharge, in million gallons, of Kahana Stream near Kahana, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	13	18	16	16	16	18	20	15	13	21	24	28
2	13	20	13	14	14	53	16	18	13	28	22	26
3	16	22	12	14	14	71	18	20	13	25	20	22
4	14	20	11	14	24	62	18	15	13	21	18	20
5	14	18	11	14	18	39	26	15	13	19	16	20
6	13	20	11	14	20	81	18	14	13	19	16	24
7	13	22	11	13	20	62	14	13	12	17	18	26
8	13	18	11	13	22	33	13	13	12	19	15	34
9	13	18	11	13	24	28	14	13	104	21	15	64
10	13	16	11	12	30	24	58	13	32	16	15	26
11	14	15	11	12	20	20	20	13	35	23	28	22
12	14	15	20	14	18	20	16	13	110	17	16	20
13	14	14	12	13	16	24	16	16	60	30	16	20
14	14	69	12	13	16	16	14	16	60	65	22	18
15	14	58	13	12	16	16	14	14	35	24	16	26
16	26	22	13	12	14	13	22	13	32	24	16	24
17	69	24	14	16	22	13	24	13	28	20	16	16
18	26	20	13	22	33	53	16	15	25	18	51	16
19	20	18	13	20	16	28	18	14	70	16	110	16
20	20	16	13	20	14	20	22	14	85	15	43	15
21	18	16	13	18	13	20	16	13	56	16	24	15
22	18	16	28	16	13	16	14	13	41	56	22	15
23	16	14	20	16	12	18	20	13	35	28	28	14
24	16	13	13	24	12	26	26	13	35	22	22	14
25	18	12	13	22	12	14	26	13	70	24	20	14
26	18	12	30	18	16	14	53	13	65	20	18	14
27	20	12	36	22	14	14	26	14	35	18	22	14
28	18	12	24	26	26	18	20	13	32	37	18	14
29	16	12	22	24	22	20	18	.....	32	56	18	13
30	18	12	16	22	18	18	16	.....	25	31	43	13
31	18	13	.....	20	.....	18	16	.....	23	.....	56	.....

NOTE.—Discharge determined from rating curves applicable as follows: July to Aug. 14, Jan. 27 to Mar. 9, and Apr. 15 to June 30, well defined below 200 million gallons per day; Aug. 15 to Jan. 26, poorly defined; Mar. 10 to Apr. 14, poorly defined. Discharge July 31 to Aug. 6, Sept. 23–25, Oct. 4–8, 29–31, Nov. 7, 14–18, Dec. 2, 4–21, 28–31, Jan. 1 and 2, and Feb. 7–11 determined by comparison with records of flow of Kaluanui stream.

Digitized by Google

Monthly discharge of Kahana Stream near Kahana, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	69	13	18.1	28.0	560	1,720
August	69	12	19.6	30.3	607	1,860
September	36	11	15.6	24.1	467	1,440
October	26	12	16.7	25.8	519	1,590
November	33	12	18.2	28.2	545	1,680
December	81	13	28.7	44.4	890	2,730
January	58	13	20.9	32.3	648	1,990
February	20	13	14.1	21.8	395	1,210
March	110	12	39.6	61.3	1,230	3,770
April	65	15	25.5	39.5	766	2,350
May	110	15	25.9	40.1	804	2,460
June	64	13	20.8	32.2	623	1,920
The year	110	11	22.1	34.2	8,050	24,700

EAST BRANCH OF KAHANA STREAM NEAR KAHANA, OAHU.

LOCATION.—Just above headquarters of Kahana Agricultural Co., 500 feet above confluence with main Kahana Stream, and 1 mile south of Kahana.

RECORDS AVAILABLE.—April 30, 1914, to March 8, 1917, when station was discontinued.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by wading or from cable.

CHANNEL AND CONTROL.—Two channels at high stages; straight for 50 feet above and below gage; left bank steep and high; right bank low and is overflowed at high stages. Control is a riffle of small boulders; not well defined; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.62 feet at 6 p. m. November 10, 1915 (discharge, approximately 200 million gallons per day, or 309 second-feet); minimum stage recorded, 1.14 feet June, 1915 (discharge, 0.8 million gallons per day, or 1.2 second feet).

Minimum stage recorded during year, 1.0 foot September, October, and February (discharge, 1.2 million gallons per day, or 1.9 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of taro.

ACCURACY.—Gage read twice daily. Records are poor owing to instability of control and infrequency of discharge measurements.

Discharge measurements of East Branch of Kahana Stream near Kahana, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Sept. 26	1.12	2.69	1.7	Dec. 21	1.14	5.09	3.3
Nov. 8	1.20	4.00	2.6				

Digitized by Google

Daily discharge, in million gallons, of East Branch of Kahana Stream near Kahana, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	1.7	2.2	1.7	1.7	2.2	2.2	4.4	4.4	1.2
2	1.7	2.2	1.7	1.7	2.2	16	4.4	3.3	1.2
3	2.2	7.4	1.7	1.7	1.7	16	4.4	5.9	1.2
4	1.7	4.4	1.7	1.2	4.4	20	4.4	4.4	1.2
5	1.7	2.2	1.7	1.2	3.3	12	5.9	3.3	1.2
6	1.7	2.2	1.7	1.7	3.3	9.0	4.4	2.2	1.2
7	1.7	2.2	1.7	1.7	3.3	24	3.3	2.2	1.2
8	1.7	2.2	1.2	1.7	3.3	20	3.3	1.7	3.3
9	1.7	2.2	1.2	1.7	3.3	12	3.3	1.7	.....
10	1.7	2.2	1.2	1.2	3.3	7.4	.....	1.7	.....
11	1.7	2.2	1.2	1.2	3.3	4.4	16	1.7	.....
12	1.7	1.7	1.2	1.2	3.3	4.4	5.9	1.7	.....
13	1.7	1.7	1.2	1.2	2.2	4.4	4.4	1.7	.....
14	1.7	9.0	1.2	1.2	2.2	4.4	3.3	2.2	.....
15	1.7	11	1.2	1.2	2.2	4.4	3.3	1.7	.....
16	1.7	5.9	1.2	1.2	4.4	3.3	5.9	1.2	.....
17	9.0	5.9	1.2	1.2	5.9	3.3	4.4	1.2	.....
18	5.9	4.4	1.7	1.7	7.4	11	4.4	1.2	.....
19	3.3	3.3	1.2	2.2	5.9	11	4.4	1.7	.....
20	2.2	3.3	1.2	3.3	3.3	3.3	7.4	1.2	.....
21	2.2	2.2	1.2	2.2	2.2	3.3	5.9	1.2	.....
22	2.2	2.2	5.9	2.2	2.2	3.3	4.4	1.2	.....
23	1.7	2.2	3.3	2.2	2.2	3.3	16	1.2	.....
24	1.7	2.2	1.2	2.2	2.2	5.9	5.9	1.2	.....
25	2.2	3.3	1.7	1.7	2.2	5.9	9.0	1.2	.....
26	2.2	2.2	1.7	2.2	2.2	4.4	26	1.2	.....
27	2.2	1.7	1.7	2.2	2.2	3.3	12	1.2	.....
28	2.2	1.7	1.7	3.3	16	14	7.4	1.2	.....
29	1.7	1.7	2.2	3.3	4.4	16	7.4	.....	.....
30	1.7	1.7	1.7	3.3	3.3	7.4	5.9	.....	.....
31	2.2	1.7	.....	3.3	.....	5.9	4.4	.....	.....

NOTE.—Discharge determined from poorly defined rating curves applicable as follows: July 1 to Aug. 15 and Dec. 9 to Mar. 8, and Aug. 16 to Dec. 8.

Monthly discharge of East Branch of Kahana Stream near Kahana, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	9.0	1.7	2.27	3.51	70	216
August	11	1.7	3.25	5.03	101	309
September	5.9	1.2	1.68	2 60	50	155
October	3.3	1.2	1.91	2.95	59	182
November	16	1.7	3.65	5.65	110	336
December	24	2.2	8.55	13.2	265	813
February	5.9	1.2	2.00	3.09	56	172
March 1–8	3.3	1.2	1.46	2.26	12	36

PUNALUU STREAM AT ELEVATION 539 FEET,[a] NEAR PUNALUU, OAHU.

LOCATION.—About a quarter of a mile below confluence of Kalena and Pio branches of the stream, and 5 miles by road and foot trail south of Punaluu railroad station.

RECORDS AVAILABLE.—April 27, 1915, to June 30, 1917.

GAGE.—Friez water-stage recorder substituted for 8-day Stevens recorder February 16, 1916.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 150 feet above gage.

CHANNEL AND CONTROL.—One channel at all stages, straight for several hundred feet above and below station; composed of boulders and gravel; right bank slopes sharply; left bank vertical; both banks fairly clean up to extreme flood stages. Control composed of large boulders; fairly permanent.

[a] Elevation given in Water-Supply Paper 430 as 600 feet.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.04 feet at 8 p. m. November 10, 1915 (discharge, approximately 300 million gallons per day, or 464 second-feet); minimum stage recorded, 0.7 foot September, 1916 (discharge, 2.0 million gallons per day, or 3.1 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Part of low-water flow is diverted at low elevation for irrigation of sugar cane, rice, and taro. Station was established to determine the feasibility of a project to divert the water of the upper Punaluu Valley to augment the water diverted from the Kahana Valley by the Waiahole Water Co.

ACCURACY.—Determinations based on rating curve well defined below 6 million gallons per day. Records good for low and medium stages.

Discharge measurements of Punaluu Stream at elevation 539 feet, near Punaluu, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 11	H. A. R. Austin	0.73	3.39	2.2
Sept. 27	do	.87	6.22	4.0
Nov. 9	do	.88	6.21	4.0
Feb. 12	R. D. Klise	.80	4.86	3.1
13	do	.80	4.80	3.1
14	do	.88	6.82	4.4
15	do	.82	5.30	3.4
Apr. 11	H. A. R. Austin	.91	7.28	4.7

Daily discharge, in million gallons, of Punaluu Stream at elevation 539 feet, near Punaluu Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.5	2.5	3.0	3.0	4.6	4.6	5.5	4.6	2.5	6.4	8.5	7.4
2	2.5	3.8	3.0	3.0	4.6	12	3.8	5.5	2.5	9.8	8.5	7.4
3	3.0	4.6	3.0	3.0	3.8	9.8	4.6	5.5	2.5	7.4	7.4	7.4
4	3.0	4.6	2.5	3.0	4.6	14	4.6	4.6	2.5	6.4	7.4	7.4
5	3.0	3.8	2.5	3.0	4.6	9.8	5.5	3.8	2.5	6.4	6.4	6.4
6	2.5	6.4	2.5	3.0	4.6	17	4.6	3.8	2.5	5.5	8.5	7.4
7	2.5	5.5	2.5	3.0	3.8	14	4.6	3.8	2.5	5.5	9.8	8.5
8	2.5	3.8	2.5	3.0	4.6	8.5	4.6	3.8	2.5	5.5	6.4	9.8
9	2.5	3.8	2.5	2.5	7.4	7.4	4.6	3.8	19	5.5	6.4	16
10	2.5	3.0	2.0	2.5	9.8	6.4	11	3.8	4.6	5.5	6.4	8.5
11	2.5	3.0	2.5	2.5	5.5	5.5	6.4	3.8	7.4	7.4	11	6.4
12	3.0	3.0	3.8	3.0	4.6	5.5	5.5	3.0	40	5.5	6.4	5.5
13	3.0	3.0	2.5	3.0	4.6	6.4	4.6	4.6	14	17	6.4	5.5
14	3.8	9.8	2.5	2.5	3.8	4.6	4.6	4.6	17	17	7.4	5.5
15	3.0	11	2.5	2.5	5.5	4.6	4.6	3.8	12	9.8	6.4	6.4
16	4.6	6.4	3.0	2.5	4.6	3.8	8.5	3.0	12	7.4	6.4	6.4
17	9.8	5.5	2.0	2.5	7.4	3.8	6.4	3.0	9.8	7.4	6.4	5.5
18	5.5	5.5	2.0	3.8	17	12	4.6	3.8	8.5	7.4	14	5.5
19	3.8	4.6	2.0	3.8	6.4	7.4	4.6	3.0	24	6.4	17	5.5
20	3.8	4.6	2.0	3.8	5.5	5.5	6.4	3.0	21	6.4	12	5.5
21	3.8	3.8	2.0	3.0	4.6	5.5	4.6	3.0	19	7.4	9.8	4.6
22	3.0	3.8	4.6	3.0	4.6	5.5	3.8	3.0	12	16	8.5	4.6
23	3.0	3.8	3.0	3.0	4.6	4.6	6.4	3.0	9.8	7.4	9.8	4.6
24	3.0	3.8	2.5	3.8	3.8	6.4	8.5	3.0	12	7.4	7.4	4.6
25	2.5	3.0	3.0	4.6	3.8	4.6	8.5	3.0	34	8.5	7.4	4.6
26	2.5	3.0	8.5	3.0	3.8	3.8	16	3.0	16	7.4	6.4	4.6
27	2.5	3.0	7.4	4.6	3.8	4.6	7.4	3.0	9.8	6.4	6.4	3.8
28	2.5	3.0	5.5	12	6.4	6.4	6.4	3.0	8.5	12	7.4	3.8
29	2.5	3.0	5.5	7.4	5.5	8.5	5.5	.....	8.5	19	7.4	3.8
30	2.5	3.0	3.8	7.4	5.5	5.5	4.6	.....	7.4	11	7.4	3.8
31	3.8	3.0	.....	5.5	.....	5.5	4.6	.....	7.4	.....	7.4	.....

NOTE.—Discharge determined from rating curve well defined below 6 million gallons per day. Discharge Jan. 9–16 and 24–26 computed by comparison with records obtained at lower Punaluu station.

Digitized by Google

Monthly discharge of Punaluu Stream at elevation 539 feet, near Punaluu, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	9.8	2.5	3.25	5.03	101	309
August	11	2.5	4.34	6.72	134	413
September	8.5	2.0	3.22	4.98	97	296
October	12	2.5	3.75	5.80	116	357
November	17	3.8	5.46	8.45	164	503
December	17	3.8	7.21	11.2	224	686
January	16	3.8	6.00	9.28	186	571
February	5.5	3.0	3.66	5.66	103	314
March	40	2.5	11.4	17.6	354	1,080
April	19	5.5	8.60	13.3	258	792
May	17	6.4	8.21	12.7	254	781
June	16	3.8	6.22	9.62	187	573
The year	40	2.0	5.96	9.22	2,180	6,680

PUNALUU STREAM AT ELEVATION 250 FEET, NEAR PUNALUU, OAHU.

LOCATION.—About 1½ miles by road and horse trail south of Punaluu railroad station.

RECORDS AVAILABLE.—May 14, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable about 150 feet below gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 200 feet above and below gage; bed composed of large boulders; right bank slopes gradually and is covered with small trees and vegetation; left bank slopes sharply and is covered with vegetation. Control composed of large boulders; apparently permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.85 feet at 5 a. m. September 23, 1914 (discharge, approximately 700 million gallons per day, or 1,080 second-feet); minimum stage recorded, 1 foot March, August, and September, 1915 (discharge, 10 million gallons per day, or 15 second-feet).

Minimum stage recorded during year, 1.05 feet July, August, September, October, and March (discharge, 12 million gallons per day, or 18.6 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Part of low-water flow is diverted for irrigation of sugar cane, rice, and taro.

ACCURACY.—Stage-discharge relation constant; rating curve good. Records good for all stages except for several short periods when discharge was estimated because there was no gage-height record.

Discharge measurements of Punaluu Stream at elevation 250 feet, near Punaluu, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 11	H. A. R. Austin	1.07	20	13
Nov. 9	do	1.13	24.8	16
Jan. 5	do	1.19	28.3	18
May 13	R. D. Klise	1.27	32.8	21

Digitized by Google

Daily discharge, in million gallons, of Punaluu Stream at elevation 250 feet, near Punaluu, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	14	14	14	14	16	19	22	22	12	25	31	28
2	14	16	14	14	16	42	16	22	12	25	28	25
3	14	19	14	14	14	34	19	25	12	28	25	22
4	14	16	12	14	16	46	19	19	12	25	25	22
5	14	14	12	14	16	34	19	19	12	22	22	22
6	12	16	12	14	16	55	19	19	12	22	26	28
7	12	19	12	12	14	46	19	16	12	22	31	31
8	12	14	12	12	16	31	19	16	14	22	22	34
9	12	14	12	12	19	28	19	16	60	22	22	28
10	12	14	12	12	28	25	34	16	19	19	19	25
11	12	14	12	19	19	22	25	16	28	25	28	22
12	14	14	14	16	16	22	22	16	100	19	19	22
13	14	12	12	19	14	25	19	22	38	38	22	22
14	14	28	12	14	14	19	19	19	42	42	25	19
15	12	38	12	14	14	19	19	16	34	28	22	25
16	16	22	14	14	14	16	31	16	38	22	22	25
17	31	19	12	14	22	16	31	16	28	22	22	22
18	19	19	12	14	50	42	22	19	25	22	55	22
19	16	19	12	16	22	28	22	16	64	19	64	19
20	14	16	12	16	19	19	28	16	69	19	34	19
21	14	16	12	16	16	19	22	14	50	22	28	19
22	14	16	16	14	16	19	19	14	34	42	25	19
23	14	16	14	14	14	19	31	14	28	25	28	19
24	12	14	12	16	14	25	31	14	31	22	25	19
25	12	14	12	16	14	19	31	14	55	31	22	19
26	12	14	25	14	14	16	50	14	38	22	22	16
27	12	14	25	16	14	19	31	16	31	22	22	16
28	12	14	19	38	22	25	28	14	28	42	22	16
29	12	14	19	28	19	28	25	.....	28	50	22	16
30	12	14	14	22	19	19	25	.....	25	38	31	16
31	14	14	.....	19	.....	19	22	.....	25	.....	42	.....

NOTE.—Discharge determined from rating curve well defined below 100 million gallons per day. Discharge Dec. 1–7, 11–19, Jan. 1–3, 6–10, Mar. 9–12, and June 6–8 determined by comparison with records of flow of Punaluu Stream at elevation 539 feet.

Monthly discharge of Punaluu Stream at elevation 250 feet, near Punaluu, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	31	12	13.9	21.5	432	1,320
August	38	12	16.7	25.8	517	1,590
September	25	12	13.9	21.5	418	1,280
October	38	12	16.2	25.1	501	1,540
November	50	14	17.9	27.7	537	1,650
December	55	16	26.3	40.7	815	2,500
January	50	16	24.5	37.9	758	2,330
February	25	14	17.0	26.3	476	1,460
March	100	12	32.8	50.7	1,020	3,120
April	50	19	26.8	41.5	804	2,470
May	64	19	27.5	42.5	852	2,620
June	34	16	21.9	33.9	657	2,020
The year	100	12	21.3	33.0	7,780	23,900

WAIHOI STREAM NEAR PUNALUU, OAHU.

LOCATION.—Half a mile above confluence with Punaluu Stream, 3 miles by road and trail from Government highway, and 6 miles by road and trail south of Hauula.

RECORDS AVAILABLE.—April 27, 1915, to June 30, 1917.

Digitized by Google

GAGE.—Vertical staff. New datum January 19, 1916. Stevens 8-day water-stage recorder in use April 27 to November 9, 1915.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL CONTROL.—One channel at all stages; very steep and rough; both banks high and wooded. Control composed of large boulders; shifts somewhat owing to growth of grass and roots at the banks.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 1.46 feet at 2 p. m. November 3, 1915 (discharge, approximately 9.0 million gallons per day, or 14 second-feet); minimum daily discharge, November 13–24, 1916 (2.5 million gallons per day, or 3.9 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Station established in connection with contemplated plan for development of Punaluu waters.

ACCURACY.—Flow so steady that water-stage recorder was removed November 9, 1915 and only weekly readings of staff gage were made after that; for this reaso some of the higher stages were doubtless not recorded. Records fair.

Discharge measurements of Waihoi Stream near Punaluu, Oahu, during the year endi June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Mill gall per
July 11	0.82	5.0	3.2	Mar. 7	0.81	5.1	
Sept. 27	.78	4.8	3.1				

Monthly discharge of Waihoi Stream near Punaluu, Oahu, for year ending June 30,

Month.	Discharge.				Total run-
	Million gallons per day.			Second-feet (mean).	Million gallons.
	Maximum.	Minimum.	Mean.		
July	4.1	3.2	3.58	5.54	111
August	3.6	3.2	3.42	5.29	106
September	3.5	3.1	3.27	5.06	98
October	3.1	2.9	3.08	4.77	96
November	3.6	2.5	2.76	4.27	83
December	3.5	3.0	3.18	4.92	98
January	4.3	3.2	3.38	5.23	105
February	3.3	3.2	3.28	5.07	92
March	4.5	3.2	4.08	6.31	126
April	4.1	4.1	4.10	6.34	123
May	4.3	4.1	4.25	6.58	13
June	4.3	3.9	4.10	6.34	12
The year	4.5	2.5	3.54	5.48	1,29

NOTE.—Determinations based on rating curves fairly well defined for ordinary stage, appl lows: July 1 to Aug. 15 and Dec. 8 to Mar. 9, Aug. 16 to Dec. 7, Mar. 10 to June 30. Discharge between weekly observations of gage height.

KALUANUI STREAM NEAR HAUULA, OAHU.

LOCATION.—At Castle's rest house, 5 miles from Government road and 7 road and trail south of Hauula.

RECORDS AVAILABLE.—April 28, 1915, to June 30, 1917.

GAGE.—Stevens continuous water-stage recorder installed February 1 place of 8-day Stevens recorder.

Digitized by Google

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—One channel at all stages; straight for 25 feet above and below gage; bed composed of boulders and gravel; right bank slopes gently; left bank steep and high. Control composed of large boulders; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorder, 4.8 feet at 2 a. m. March 9, 1917 (discharge, approximately 200 gallons per day, or 309 second-feet); minimum stage recorded, 0.75 foot February 25 and 26, 1917 (discharge, 0.25 million gallons per day, or 0.39 second-foot).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane and rice.

ACCURACY.—Records based on well-defined rating curve and a continuous record of gage height; good for all stages.

Discharge measurements of Kaluanui Stream near Hauula, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Sept. 27	H. A. R. Austin	1.28	3.57	2.3
Jan. 5	do	1.42	5.67	3.7
May 12	R. D. Klise	1.04	.6	.35

Daily discharge, in million gallons, of Kaluanui Stream near Hauula, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	1.0	2.6	1.7	1.0	2.6	2.1	4.0	0.8	0.4	1.3	3.2	2.1
2	.8	4.7	2.1	1.0	1.7	16	3.2	1.0	.35	1.0	2.6	1.3
3	4.7	2.1	.8	.65	1.7	9.2	3.2	1.0	.4	1.3	3.2	1.3
4	2.1	4.7	.8	.65	4.0	9.2	2.6	.8	3.2	.8	2.1	.8
5	1.7	1.3	.65	.5	3.2	3.2	2.1	.65	.8	.8	1.3	.8
6	1.0	2.1	.5	.65	2.6	5.7	2.1	.5	.6	.6	1.0	1.0
7	.8	2.6	.5	.5	4.7	6.7	1.3	.5	.6	.6	1.3	1.3
8	.8	1.3	.5	.65	4.0	2.6	1.0	.5	1.0	.5	1.0	1.7
9	.65	1.0	2.1	1.3	4.0	2.6	1.0	.5	14	2.1	.8	5.7
10	.65	.8	.65	.65	3.2	2.6	9.2	.45	2.6	.6	.8	1.7
11	1.0	1.7	.5	.45	2.1	1.7	2.1	.45	2.1	3.2	1.3	1.7
12	2.6	1.7	1.0	3.2	1.7	1.7	1.3	.45	20	2.1	.6	1.0
13	1.0	1.0	.65	1.3	1.3	3.2	1.0	1.3	4.7	2.6	1.7	1.0
14	1.3	8.0	.5	1.0	1.3	2.1	.8	3.2	8.0	3.2	3.2	.8
15	.65	11	.45	.8	4.0	1.7	.8	.65	6.7	3.2	1.7	3.2
16	2.6	2.1	1.7	.65	1.7	2.6	4.7	.5	8.0	2.6	1.7	4.0
17	12	4.0	.5	.8	8.0	3.2	3.2	.45	4.0	1.7	2.1	1.3
18	2.6	3.2	.45	2.1	12	11	1.0	.65	4.0	1.3	11	1.7
19	1.7	3.2	.65	2.6	2.6	4.0	1.0	.8	12	1.0	5.7	1.0
20	1.7	2.6	.65	2.6	2.6	2.1	8.0	.45	15	1.0	2.6	.8
21	1.3	2.6	.65	2.1	1.7	1.7	1.3	.4	5.7	1.7	1.7	.8
22	1.0	2.1	3.2	1.7	1.3	2.1	1.0	.35	3.2	8.0	1.0	.6
23	.8	1.7	2.1	2.1	1.3	4.0	4.7	.3	2.1	2.6	4.0	.6
24	.65	1.3	1.0	4.7	1.3	5.7	2.6	.3	2.1	2.1	1.7	.6
25	.8	1.3	1.3	2.6	2.1	2.1	1.7	.25	14	6.7	1.0	.5
26	.8	.8	5.7	2.6	2.6	1.7	11	.25	4.7	2.6	.8	.5
27	2.1	.8	4.7	4.0	1.7	3.2	3.2	.3	2.1	2.1	1.0	.5
28	1.7	.8	2.1	14	5.7	6.7	1.7	1.7	2.6	24	1.7	.6
29	.8	.8	2.1	4.0	3.2	4.7	1.3	.....	2.6	24	.8	.5
30	1.3	.8	1.0	4.0	3.2	2.1	1.7	.....	1.3	8.0	4.0	.5
31	2.1	1.3	.....	2.6	.....	1.7	.8	.....	2.1	.....	4.0	.....

NOTE.—Discharge determined from well-defined rating curve. Discharge Jan. 3-5 determined by comparison with records of flow of Punaluu Stream.

Digitized by Google

Monthly discharge of Kaluanui Stream near Hauula, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	12	0.65	1.76	2.72	55	167
August	11	.8	2.45	3.79	76	233
September	5.7	.45	1.37	2.12	41	126
October	14	.45	2.18	3.37	67	207
November	12	1.3	3.10	4.80	93	285
December	16	1.7	4.16	6.44	129	396
January	11	.8	2.73	4.22	85	260
February	3.2	.25	.69	1.07	19	59
March	20	.35	4.87	7.54	151	463
April	24	.5	3.78	5.85	113	348
May	11	.6	2.28	3.53	71	217
June	5.7	.5	1.33	2.06	40	122
The year	24	.25	2.58	3.99	940	2,880

KOLOA STREAM NEAR LAIE, OAHU.

LOCATION.—At elevation about 500 feet, 3 miles by horse trail southwest of Laie.

RECORDS AVAILABLE.—July 30, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable about 20 feet below gage.

CHANNEL AND CONTROL.—Channel straight for a hundred feet above station; right bank clean and perpendicular; left bank clean with gradual slope to above high-water stage. On October 23, 1915, a reinforced concrete control 33 feet long having a low-water notch 16 feet in length was completed.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.2 feet at 11 a. m. November 11 (discharge, computed by extension of rating curve, approximately 300 million gallons per day, or 464 second-feet); minimum stage recorded, 0.1 foot October 1–8 (discharge, 0.3 million gallons per day, or 0.46 second-foot).

Maximum stage recorded during period of record, 5.3 feet at 9 a. m. September 25, 1914 (discharge, approximately 755 million gallons per day, or 1,170 second-feet); minimum discharge, less than 0.1 million gallons per day, or 0.15 second-foot.

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Stream is not perennial in its lower course. A small part of the flood discharge is diverted at low elevation for irrigation of sugar cane. Station was established to determine whether the total discharge of the streams would justify the construction of a large flood-water storage project in the vicinity.

ACCURACY.—Records based on rating curve well defined below 40 million gallons per day; good below that limit. Discharge for days of decided fluctuation in stage computed hourly.

Discharge measurements of Koloa Stream near Laie, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Sept. 6	C. T. Bailey	0.13	0.5	0.3
Nov. 11	H. A. R. Austin	.22	2.49	1.6
Jan. 4	do	.28	3.43	2.2
Mar. 9	do	.38	5.97	3.9
Apr. 12	do	.22	1.73	1.1

Digitized by Google

Daily discharge, in million gallons, of Koloa Stream near Laie, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	0.6	2.2	1.0	0.3	1.6	2.2	1.6	1.0	0.6	1.0	4.0	1.6
2	.6	2.2	.6	.3	1.6	13	2.2	1.0	.6	1.0	3.1	1.6
3	.6	1.0	.6	.3	1.0	4.0	4.0	1.6	.6	1.0	3.1	1.0
4	.6	3.1	.6	.3	2.2	5.3	3.1	1.0	2.2	1.0	3.1	1.0
5	.6	1.0	.6	.3	3.1	8.1	6.6	1.0	1.0	1.0	2.2	1.0
6	.6	1.0	.6	.3	2.2	15	2.2	1.0	.6	1.0	2.2	1.0
7	.6	1.0	.6	.3	4.0	11	1.6	.6	.6	1.0	2.2	1.0
8	.6	.6	.6	.3	2.2	3.1	1.6	.6	14	1.0	2.2	1.0
9	.6	.6	1.6	1.0	1.6	4.0	1.6	.6	19	1.0	2.2	3.1
10	.6	.6	1.0	1.0	2.2	4.0	12	.6	3.1	1.0	2.2	1.6
11	.6	.6	.6	.6	1.0	2.2	4.0	.6	1.6	1.0	2.2	1.6
12	.6	.6	1.6	7.9	1.0	1.6	2.2	.6	24	6.0	2.2	1.0
13	.6	.6	1.0	1.6	1.0	5.3	1.6	1.0	3.1	2.2	1.6	.6
14	.6	.6	1.0	1.0	1.0	2.2	1.6	3.1	4.0	2.2	2.2	.6
15	.6	8.1	.6	1.0	3.1	1.6	1.6	.6	4.0	2.2	1.6	5.0
16	.6	1.0	1.0	1.0	1.6	1.6	7.9	.6	11	3.1	1.6	8.8
17	8.1	.6	.6	1.6	14	1.6	14	.6	3.1	1.0	1.6	1.6
18	1.0	1.0	.6	3.1	31	9.6	2.2	1.6	3.1	1.0	13	1.6
19	.6	1.0	.6	4.0	2.2	4.0	1.6	1.6	12	1.0	8.9	1.0
20	.6	1.0	.6	1.6	1.6	2.2	9.6	.6	19	1.0	2.2	1.0
21	.6	.6	.6	1.6	1.6	1.6	2.2	.6	4.0	1.0	1.6	1.0
22	.6	.6	1.0	1.0	1.6	1.0	1.6	.6	2.2	6.6	1.0	1.0
23	.6	.6	1.0	1.6	1.0	1.6	14	.6	1.6	2.2	3.1	1.0
24	.6	.6	1.0	2.2	1.6	9.0	2.2	.6	1.0	2.2	1.6	1.0
25	.6	.6	1.0	2.2	2.2	1.6	1.6	.6	5.3	9.6	1.0	.6
26	.6	.6	1.0	1.6	2.2	1.6	9.6	.6	2.2	3.1	1.0	.6
27	.6	.6	1.0	5.3	1.6	6.1	2.2	1.6	1.0	5.3	1.0	.6
28	.6	.6	1.6	9.6	5.3	4.5	1.6	1.6	1.6	19	3.1	.6
29	.6	.6	.6	2.2	1.6	12	1.6	.....	1.0	24	1.6	.6
30	.6	.6	.6	1.6	2.2	2.2	1.6	.....	1.0	8.1	1.6	.6
31	1.0	.6	.....	1.6	.....	1.6	1.6	.....	1.0	.....	3.1	.....

NOTE.—Discharge determined from rating curve well defined below 40 million gallons per day. Discharge July 1-27, Aug. 8 to Sept. 5, Sept. 18 to Oct. 5, Oct. 15 to Nov. 10, Dec. 3-6, and Apr. 23 to May 14 determined by comparison with records of flow of Wailele Stream.

Monthly discharge of Koloa Stream near Laie, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	8.1	0.6	0.87	1.35	27	83
August	8.1	.6	1.13	1.75	35	108
September	1.6	.6	.85	1.32	25	78
October	9.6	.3	1.88	2.91	58	179
November	31	1.0	3.34	5.17	100	308
December	15	1.0	4.66	7.21	144	443
January	14	1.6	3.95	6.11	123	376
February	3.1	.6	.95	1.47	27	82
March	24	.6	4.81	7.44	149	458
April	24	1.0	3.73	5.77	112	343
May	13	1.0	2.69	4.16	83	256
June	8.8	.6	1.48	2.29	44	136
The year	31	.3	2.54	3.93	927	2,850

WAILELE STREAM NEAR LAIE, OAHU.

LOCATION.—About 3 miles by horse trail southwest of Laie and about 525 feet above sea level.

RECORDS AVAILABLE.—July 30, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 20 feet above gage.

CHANNEL AND CONTROL.—Channel straight for about 50 feet above gage; right bank sloping and clean; left bank nearly vertical. Control consists of concrete slab 32 feet long with low-water notch 14 feet long.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.85 feet at 9 a. m. September 23, 1914 (discharge, approximately 295 million gallons per day, or 456 second-feet); stream occasionally dry.

Maximum stage recorded during year, 3.25 feet at 3 a. m. November 18 (discharge, approximately 140 million gallons per day, or 217 second-feet); minimum stage recorded, 0.2 foot October 6–8 (discharge 0.1 million gallons per day, or 0.15 second-foot).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Stream not perennial. A small part of the flood discharge is diverted at low elevations for sugar-cane irrigation. Station was established to determine whether the total flood discharge of streams at 500 feet above sea level will justify the construction of a large flood-water storage project in the vicinity.

ACCURACY.—Records based on rating curve well defined below 6 million gallons per day and continuous record of gage height; good for medium stages; determinations of daily discharge for periods of extreme low water may be somewhat in error because of the small amount of water involved and lack of sensitiveness of control; discharge for days of decided fluctuation in stage computed hourly.

Discharge measurements of Wailele Stream near Laie, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Nov. 11	0.28	1.07	0.7	Mar. 9	.48	3.57	2.3
Dec. 6	.55	6.83	4.4	Apr. 12	.30	1.20	.8
Jan. 4	.36	2.09	1.4				

Daily discharge, in million gallons, of Wailele Stream near Laie, Oahu, for the year ending June 30, 1917.

Date.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	.....	0.8	1.3	0.8	0.4	0.4	0.8	2.7	0.8
2	.....	.8	7.6	1.3	.4	.4	.8	2.0	.4
3	.....	.4	2.7	2.0	.4	.4	.8	2.0	.4
4	.....	1.3	3.5	2.0	.4	1.3	.8	2.0	.4
5	.....	2.0	4.4	2.7	.4	.4	.4	1.3	.4
6	0.1	1.3	7.6	1.3	.4	.4	.4	1.3	.4
7	.1	2.7	5.4	1.3	.4	.4	.4	1.3	.4
8	.1	1.3	2.7	.8	.4	2.7	.4	1.3	.4
9	.4	.8	2.7	.8	.4	7.6	.8	1.3	.8
10	.4	1.3	2.7	5.4	.4	2.0	.8	1.3	.4
11	.4	.8	2.0	2.7	.4	1.3	.8	1.3	.4
12	2.0	.4	1.3	1.3	.4	11	.8	1.3	.4
13	1.3	.4	3.5	1.3	.4	2.0	1.3	.8	.4
14	.4	.4	2.0	.8	2.0	2.0	1.3	1.3	.4
15	.4	1.3	1.3	.8	.4	2.0	1.3	.8	2.0
16	.4	.8	1.3	4.4	.4	4.4	1.3	.8	5.2
17	.8	4.4	1.3	3.5	.4	2.0	.8	1.3	.8
18	2.0	16	5.4	1.3	.8	2.0	.8	6.5	.8
19	2.7	2.0	2.7	1.3	.8	5.9	.8	4.0	.8
20	.8	1.3	2.0	5.4	.4	7.7	.8	1.3	.4
21	.8	.8	1.3	1.3	.4	2.7	.8	.8	.4
22	.4	.8	1.3	1.3	.4	1.3	2.7	.4	.4
23	.8	.8	1.3	7.9	.4	.8	1.3	1.3	.4
24	1.3	.8	4.4	2.0	.4	.8	1.3	.8	.4
25	1.3	1.3	1.3	1.3	.4	2.7	9.1	.4	.4
26	.8	1.3	1.3	4.4	.4	1.3	2.0	.4	.4
27	7.8	.8	2.7	1.3	.8	.8	3.5	.4	.4
28	6.5	3.5	2.7	.8	.8	.8	9.8	1.3	.4
29	1.3	.8	4.4	1.3	.....	.8	12	.8	.4
30	.8	1.3	1.3	1.3	.....	.8	4.4	.4	.4
31	.8	.....	1.3	.8	.....	.8	.....	1.3	.....

NOTE.—Discharge determined from rating curve well defined below 6 million gallons per day. Gage height record July 1 to Oct. 5 unreliable. Discharge Nov. 17, 26–30, Dec. 1–6, and Feb. 13 to Mar. 9 determined by comparison with records of flow of Koloa Stream.

Digitized by Google

Monthly discharge of Wailele Stream near Laie, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
October 6-31	7.8	0.1	1.34	2.07	35	107
November	16	.4	1.76	2.72	53	162
December	7.6	1.3	2.80	4.33	87	266
January	7.9	.8	2.09	3.23	65	199
February	2.0	.4	.51	.79	14	44
March	11	.4	2.25	3.48	70	214
April	12	.4	2.11	3.26	63	194
May	6.5	.4	1.43	2.21	44	136
June	5.2	.4	.68	1.05	20	63
The period					451	1,380

EAST BRANCH OF KAHAWAINUI STREAM NEAR LAIE, OAHU.

LOCATION.—Half a mile above junction with West Branch of Kahawainui Stream, 3 miles by horse trail southwest of Laie, about 500 feet above sea level.

RECORDS AVAILABLE.—July 29, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder. Datum raised 0.6 foot November 1, 1915.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 10 feet below gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for several feet above station; bed composed of large boulders; free from vegetation; right bank clean and nearly perpendicular; left bank sloping and fairly clean. Control prior to October 26, 1915, consisted of a natural dam of large boulders. On November 1, 1915, a reinforced concrete control, 32 feet long with a low-water notch 15 feet long was completed.

EXTREME OF DISCHARGE.—Maximum stage recorded during year, 2.5 feet at 4 a. m. November 18 (discharge, approximately 150 million gallons per day, or 232 second-feet).

Maximum stage recorded during period of record, 5.1 feet at 7 a. m. September 25, 1914 (discharge, approximately 340 million gallons per day, or 526 second-feet); channel frequently dry.

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Part of the flood discharge is diverted at low elevations to irrigate sugar cane. Station was established to determine whether total flood discharge at this elevation is sufficient to justify a large flood water stored from project near Kahuku.

ACCURACY.—Determinations based on a fairly well defined rating curve. Records good except for very low stages for which they may be in error because of small amount of water involved. Discharge for days of decided fluctuation in stage computed hourly.

Discharge measurements of East Branch of Kahawainui Stream near Laie, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Nov. 10	0.32	0.93	0.6	Mar. 8	.36	1.29	.85
Dec. 6	.49	3.16	.0	Apr. 12	.32	1.11	.7
Jan. 6	.33	.53	.35				

Digitized by Google

Daily discharge, in million gallons, of East Branch of Kahawainui Stream near Laie, Oahu, for the year ending June, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1		0.1				0.7	0.4	0.4		0.2	0.1	
2		.4				3.9	.7	.4		.2		
3		.2				2.8	1.6	.4		.2		
4		.7				2.1	1.1	.4	0.4	.2	.7	
5					0.1	4.8	1.6	.2	.2	.2		
6						6.4	.7	.2	.1	.2		
7					.2	2.1	.4	.1	.1			
8						1.1	.4	.1	7.2			
9						1.1	.4		4.3	.2		
10					.7	1.1	4.2		.7	.2		
11					.4	.4	1.1		.2	.4		
12	1.1			2.8	.2	.4	.7		9.6	.4		
13				.6	.2	1.6	.4	.1	1.1	.2		
14		.7		.1	.1	.7	.4	1.1	1.1	.4	.2	
15		3.5			.2	.4	.4	.2	1.1	.4	.4	0.7
16	5.0	.2			.2	.4	3.7	.1	4.5	.7	.4	4.2
17	28	.1			4.6	.4	3.8		1.1	.4	.7	.4
18	2.1	.4		1.1	16	2.1	.4	.9	1.6	.2	4.3	.4
19	.2	.2		2.1	1.1	.7	.4	.4	4.9	.1	1.1	.2
20	.1	.1		.4	.7	.2	5.0	.1	6.6		.7	
21	.1	.1		.2	.7	.2	.7		2.8		.2	
22				.2	.7	.2	.7		1.1	1.1	.1	
23				.2	.4	.4	5.1		.4	.2	.2	
24				.7	.4	2.1	.4		.2	.4	.1	
25				1.1	.7	.4	.4		1.1	6.2		
26				.4	1.1	.2	2.8		.4	.7		
27				3.3	.4	.7	.7	.3	.2	1.6		
28				8.4	1.6	1.1	.7	.4	.7	4.5		
29				.2	.7	3.2	1.1		.4	4.2		
30				.1	1.1	.4	1.1		.4	.4		
31				.1		.4	.4		.2			

NOTE.—Discharge determined from rating curve fairly well defined below 80 million gallons per day. No flow on days for which discharge is not given.

Monthly discharge of East Branch of Kahawainui Stream near Laie, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	28	0	1.18	1.83	37	112
August	3.5	0	.22	.34	7	21
October	8.4	0	.71	1.10	22	68
November	16	0	1.08	1.67	32	99
December	6.4	.2	1.38	2.14	43	131
January	5.1	.4	1.35	2.09	42	128
February	1.1	0	.21	.32	6	18
March	9.6	0	1.70	2.63	53	162
April	6 2	0	.80	1.24	24	74
May	4.3	0	.30	.46	9	29
June	4.2	.2	.20	.31	6	18
The year	28	0	.77	1.19	281	860

Digitized by Google

EAST BRANCH OF MALAEKAHANA STREAM NEAR KAHUKU, OAHU.

LOCATION.—About three-quarters of a mile above junction with Middle Branch of Malaekahana stream and 3½ miles by horse trail south of Kahuku, about 375 feet above sea level.

RECORDS AVAILABLE.—July 31, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder. Original staff gage, established on July 31, 1914, was washed out by flood September 24, 1914. From September 25, 1914, to May 28, a reference point consisting of 20-penny nail in kukui tree on left bank 50 feet upstream, at same datum as staff gage, was used to check gage heights. On May 28, 1915, a new staff gage was established at the original datum.

DISCHARGE MEASUREMENTS.—Made by wading or from cable about 5 feet upstream from staff gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for several hundred feet above gage; bed composed of loose boulders and gravel; right bank at gage clean and nearly vertical; left bank has gradual slope and above ordinary flood stages is covered with small trees and vegetation; cross section same for several hundred feet upstream. Reinforced concrete control completed November 9, 1915, is 33 feet long with a 14-foot notch for low water. Original control consisted of a concrete slab 2 feet wide, with a small notch for low flow, between large boulders, about 6 feet below gage; this control was destroyed by the flood September 24, 1914.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.15 feet at 6 p. m. March 8, 1916 (discharge, computed by extension of the rating curve, approximately 90 million gallons per day, or 139 second-feet).

Maximum stage recorded during period of record, 5.05 feet at 5 a. m. September 25, 1914 (discharge, approximately 378 million gallons per day, or 585 second-feet); channel frequently dry.

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Stream not perennial. A small part of the flood discharge is diverted at low elevations for irrigation of sugar cane. Station was established to determine whether the total flood discharge at an elevation of about 350 feet above sea level will justify the construction of a large flood-water storage project near Kahuku.

ACCURACY.—Records based on rating curve well defined below 12 million gallons per day; good below that limit except for very low stages for which they may be in error because of small amount of water involved. Discharge for days of decided fluctuation in stage computed hourly.

Discharge measurements of East Branch of Malaekahana Stream near Kahuku, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.
Nov. 10	0.13	0.78	0.50
Jan. 6	.16	1.00	.64

Digitized by Google

Daily discharge, in million gallons, of East Branch of Malaekahana Stream near Kahuku, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	.....	.....	0.3	.....	0.3	0.3	1.0	1.0	0.3	0.3	1.0	0.3
2	.....	0.3	.....	.....	.....	3.5	1.8	1.0	.3	.3	1.0	.3
3	.....	.3	.....	.....	.....	2.6	2.6	.3	.3	.3	1.0	.3
4	.....	1.0	.....	.....	.3	3.5	1.8	.3	1.0	.3	4.2	.3
5	.....	.....	.....	.....	1.8	6.6	2.6	.3	1.0	.3	1.0	.3
6	.....	.....	.....	.....	.3	8.9	1.0	.3	.3	.3	.3	.3
7	.....	.3	.....	.....	1.8	4.5	1.0	.3	.3	.3	.3	.3
8	.....	.....	.....	.....	1.0	1.8	1.0	.3	9.9	.3	.3	.3
9	.....	.....	.....	.....	.3	1.8	1.0	.3	4.5	.3	.3	.3
10	.....	.....	.....	.....	1.0	1.8	6.5	.3	1.0	.3	.3	.3
11	.....	.....	.....	.....	.3	1.0	2.6	.3	.3	.3	1.0	.3
12	.....	.....	.....	3.0	.3	1.0	1.0	.3	8.8	.3	.3	.3
13	.....	.....	.....	1.0	.3	1.8	1.0	.3	1.8	.3	.3	.3
14	.....	.....	.....	.3	.3	1.0	.3	1.8	1.8	.3	.3	.3
15	.....	5.3	.....	.....	1.0	1.0	.3	.3	1.0	.3	.3	1.8
16	.....	.3	.....	.....	1.0	.3	5.7	.3	5.5	1.8	.3	9.1
17	5.5	.....	.3	.....	4.0	.3	5.2	.3	1.8	.3	1.0	1.0
18	.3	.3	.....	.....	11	3.5	1.0	1.0	1.8	.3	3.5	.3
19	.....	.3	.....	1.0	1.0	1.8	1.0	1.0	4.5	.3	1.8	.3
20	.....	.3	.....	.3	.3	1.0	5.5	.3	7.5	.3	1.0	.3
21	.....	.....	.....	.3	.3	.3	1.0	.3	2.6	.3	1.0	.3
22	.....	.....	.3	.....	.3	.3	1.0	.3	1.0	1.8	1.0	.3
23	.....	.....	.3	.....	.3	.3	5.7	.3	1.0	.3	1.0	.3
24	.....	.....	.3	.....	.3	3.5	1.0	.3	.3	.3	1.0	.3
25	.....	.....	.3	1.0	.3	1.0	1.0	.3	3.5	4.6	1.0	.3
26	.....	.....	.3	.3	1.0	.3	4.5	.3	1.0	1.0	1.0	.3
27	.....	.....	.3	2.3	.3	1.0	1.8	1.0	1.0	1.8	1.0	.3
28	.....	.....	1.0	6.9	1.0	3.5	1.0	1.0	1.0	7.5	1.0	.3
29	.....	.....	.....	1.0	.3	2.6	1.8	.....	1.0	8.6	1.0	.3
30	.....	.....	.....	.3	.3	1.0	1.0	.....	1.0	3.5	.3	.3
31	.....	.....	.....	.3	.....	.3	1.0	.....	.3	.....	.3	.....

NOTE.—Discharge determined from rating curve well defined below 12 million gallons per day. Discharge interpolated Jan. 31 to Feb. 6. No flow on days for which discharge is not given.

Monthly discharge of East Branch of Malaekahana Stream near Kahuku, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	5.5	0	0.19	0.29	6	18
August	5.3	0	.27	.42	8	26
September	1.0	0	.11	.17	3	10
October	6.9	0	.58	.90	18	55
November	11	0	1.02	1.58	31	94
December	8.9	.3	2.00	3.09	62	190
January	6.5	.3	2.09	3.23	65	199
February	1.8	.3	.50	.77	14	43
March	9.9	.3	2.17	3.36	67	206
April	8.6	.3	1.24	1.92	37	114
May	4.2	.3	.94	1.45	29	89
June	9.1	.3	.67	1.04	20	62
The year	11	0	.99	1.53	360	1,110

MIDDLE BRANCH OF MALAEKAHANA STREAM NEAR KAHUKU, OAHU.

LOCATION.—About a mile above junction with East Branch of Malaekahana Stream; 3½ miles by horse trail south of Kahuku, about 440 feet above sea level.

RECORDS AVAILABLE.—July 31, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder. Gage datum lowered 1 foot September 25, 1914, to avoid minus readings.

Digitized by Google

DISCHARGE MEASUREMENTS.—Made by wading or from cable 15 feet downstream from staff gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for several hundred feet above gage; bed composed of loose boulders and gravel; free from vegetation; at the gage right bank clean and nearly vertical; left bank slopes gradually and above ordinary flood stages is covered with trees and vegetation. Reinforced concrete control completed November 20, 1915, replacing concrete control washed out September 24, 1914.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 3.40 feet at 9.30 p. m. January 7, 1916 (discharge, approximately 200 million gallons per day, or 309 second-feet); channel dry greater part of the time.

Maximum stage recorded during year, 0.96 foot at 3 a. m. December 6 (discharge, approximately 40 million gallons per day, or 62 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Stream not perennial. A small part of the flood discharge is diverted at low elevations for irrigation of sugar cane. Station was established to determine whether the total flood discharge at an elevation of about 400 feet above sea level will justify the construction of a large flood-water storage project near Kahuku.

ACCURACY.—Determinations are based on rating curve well defined for low and medium stages. Records only fair on account of the small amount of water involved. Discharge for days of decided fluctuation in stage computed hourly.

The following discharge measurement was made by H. A. R. Austin:

January 6, 1917: Gage height, 0.26 foot; discharge, 0.9 second-foot, or 0.6 million gallons per day.

Daily discharge, in million gallons, of Middle Branch of Malaekahana Stream near Kahuku, Oahu, for the year ending June 30, 1917.

Date.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1					0.05			0.05	
2					.05			.05	
3			0.05		.05				
4			.5		.05			.4	
5					.05				
6			4.0	0.5	.05				
7				.5	.05				
8				.5	.05	0.3			
9				.5	.05				
10				2.5	.05				
11				.5				.2	
12				.5		.3			
13				.5					
14				.5	.05				
15				.5	.05				
16				2.5		.2			2.2
17				2.5					
18		1.3		.5				.05	
19				.5				.05	
20				2.5		.6		.05	
21				.5		.4		.05	
22				.5					
23				.5					
24				.05					
25				.05			1.2		
26				.5					
27	.9			.05			.1		
28	1.3			.05	.6		1.2		
29				.05			2.5		
30				.05			.5		
31				.05					

NOTE.—Discharge determined from rating curve well defined below 8 million gallons per day. No flow during August and September, or on days for which discharge is not given, except July 10–25, and Dec. 7 to Jan. 5, for which gage heights were not recorded.

Digitized by Google

Monthly discharge of Middle Branch of Malaekahana Stream near Kahuku, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
October	1.3	0	0.07	0.11	2	7
November	1.3	0	.04	.06	1	4
December 1-6	4.0	0	.76	1.18	5	14
January 6-31	2.5	0.05	.69	1.07	18	55
February	.6	0	.04	.06	1	3
March	.6	0	.06	.09	2	6
April	2.5	0	.18	.28	6	17
May	.4	0	.03	.05	1	3
June	2.2	0	.07	.11	2	6

RIGHT BRANCH OF NORTH FORK OF KAUKONAHUA STREAM NEAR WAHIAWA, OAHU.

LOCATION.—About 200 feet upstream from intake of Wahiawa Water Co.'s tunnel which is at the confluence of the right and left branches, or two main branches, of North Fork, about 8 miles northeast of Wahiawa.

RECORDS AVAILABLE.—May 29, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 20 feet upstream from gage.

CHANNEL AND CONTROL.—Channel is a straight stretch 200 feet long that has been cleared of boulders. Banks steep and flow well distributed and confined. Natural control of large boulders has been improved somewhat for low-water stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.75 feet at 5 p. m. April 14 (discharge, approximately 400 million gallons per day, or 619 second-feet); minimum stage recorded, 1.4 feet February 28 to March 2 (discharge, 0.7 million gallons per day, or 1.1 second-feet).

Maximum stage recorded during period of record, 6.9 feet 10 p. m. November 8, 1914 (discharge, estimated by extension of rating curve, 560 million gallons per day, or 866 second-feet); minimum daily discharge, March, 1914 (0.2 million gallons per day, or 0.3 second-feet).

DIVERSIONS.—None above station; entire low-water flow below station diverted.

REGULATION.—None.

UTILIZATION.—Wahiawa Water Co.'s ditch diverts entire low-water flow of both right and left branches of North Fork at their confluence below gaging station on each branch for domestic water supply and irrigation in vicinity of Wahiawa. Discharge from North Fork is impounded in Wahiawa reservoir for irrigation of sugar cane on Waialua plantation.

ACCURACY.—Records based on well-defined rating curve and continuous record of gage height; good for all stages.

Discharge measurements of right branch of North Fork of Kaukonahua Stream near Wahiawa, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Sept. 1	2.03	12.2	7.9	Mar. 1	1.39	0.79	0.5
Jan. 3	1.99	12	7.7	May 2	2.02	12.7	8.2

Digitized by Google

Daily discharge, in million gallons, of right branch of North Fork of Kaukonahua Stream near Wahiawa, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	3.8	8.0	5.2	4.5	10	7.0	12	3.0	0.7	7.0	6.0	26
2	3.0	10	6.0	3.8	9.0	26	12	5.2	.7	8.0	6.0	18
3	8.0	9.0	3.0	3.0	7.0	12	12	7.0	1.0	13	5.2	9.0
4	7.0	12	2.5	3.0	16	22	9.0	3.8	3.0	5.2	7.0	5.2
5	4.5	7.0	2.5	2.5	13	8.0	16	2.5	1.2	5.2	5.2	6.0
6	3.0	12	2.5	2.5	10	8.0	9.0	2.5	1.0	3.8	3.8	14
7	2.5	20	2.5	2.5	14	20	6.0	2.5	1.0	3.8	12	10
8	2.5	9.0	2.0	2.0	20	8.0	5.2	2.5	1.2	3.8	3.8	20
9	2.5	7.0	3.8	2.0	20	7.0	4.5	2.0	8.0	6.0	5.2	36
10	2.0	5.2	2.5	2.0	34	7.0	26	2.0	1.6	3.0	6.0	10
11	2.5	5.2	2.5	1.6	12	5.2	8.0	2.0	14	14	32	10
12	7.0	6.0	8.0	5.2	9.0	5.2	6.0	2.0	59	9.0	7.0	8.0
13	5.2	5.2	2.5	4.5	8.0	9.0	4.5	3.0	18	26	7.0	7.0
14	3.8	36	2.0	3.8	6.0	6.0	4.5	5.2	29	101	10	6.0
15	2.0	18	2.0	4.5	9.0	4.5	3.8	2.0	32	32	8.0	9.0
16	14	8.0	2.5	4.5	6.0	4.5	9.0	2.0	16	24	8.0	9.0
17	39	12	4.5	4.5	29	5.2	7.0	1.6	10	18	7.0	5.2
18	18	9.0	3.8	9.0	36	42	3.8	2.5	8.0	12	44	7.0
19	8.0	8.0	4.5	9.0	10	32	4.5	2.5	32	9.0	44	4.5
20	7.0	8.0	2.5	7.0	8.0	9.0	9.0	1.6	26	7.0	18	4.5
21	10	7.0	3.8	4.5	7.0	8.0	3.8	1.6	18	7.0	10	3.8
22	4.5	6.0	16	3.8	6.0	10	3.0	1.2	8.0	18	8.0	3.8
23	3.8	4.5	5.2	5.2	5.2	13	3.8	1.2	6.0	10	20	3.0
24	3.8	4.5	3.8	12	4.5	12	22	1.0	18	9.0	9.0	3.0
25	3.8	3.8	13	14	8.0	6.0	7.0	1.0	66	7.0	7.0	2.5
26	3.0	3.8	18	4.5	12	5.2	20	1.0	36	5.2	6.0	2.5
27	5.2	3.8	12	20	9.0	7.0	6.0	1.0	12	5.2	6.0	2.5
28	4.5	3.8	7.0	47	14	9.0	4.5	.7	10	9.0	7.0	2.5
29	3.0	3.0	6.0	32	13	14	4.5	.....	9.0	26	6.0	2.0
30	3.8	3.0	4.5	53	12	6.0	3.8	.....	6.0	9.0	12	2.0
31	12	4.5	.....	16	.....	4.5	3.0	.....	6.0	.....	44	.....

NOTE.—Discharge determined from well-defined rating curve. Discharge Sept. 11-21, 26-30, Oct. 1-10, and June 2-7 determined by comparison with record of flow of left branch.

Monthly discharge of right branch of North Fork of Kaukonahua Stream near Wahiawa, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	39	2.0	6.54	10.1	203	622
August	36	3.0	8.46	13.1	262	805
September	18	2.0	5.22	8.08	157	481
October	53	1.6	9.46	14.6	293	900
November	36	4.5	12.6	19.5	377	1,160
December	42	4.5	11.0	17.0	342	1,050
January	26	3.0	8.17	12.6	253	777
February	7.0	.7	2.36	3.65	66	203
March	66	.7	14.8	22.9	458	1,410
April	101	3.0	13.9	21.5	416	1,280
May	44	3.8	12.3	19.0	380	1,170
June	36	2.0	8.40	13.0	252	773
The year	101	.7	9.48	14.7	3,460	10,600

LEFT BRANCH OF NORTH FORK OF KAUKONAHUA STREAM NEAR WAHIAWA, OAHU.

LOCATION.—100 feet above the intake of the Wahiawa Water Co.'s tunnel, which is at the confluence of the right and left branches, or the two main branches, of the North Fork about 8 miles northeast of Wahiawa.

RECORDS AVAILABLE.—May 25, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable at gage.

Digitized by Google

CHANNEL AND CONTROL.—Channel straight for 100 feet above and below gage; fairly uniform in cross section with high, wooded banks; only one channel at all stages. Stream bed composed of bowlders and gravel. Control composed of large bowlders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 7.3 feet at 10 p. m. March 19, 1917 (discharge, approximately 850 million gallons per day, or 1,320 second-feet); minimum stage recorded, 0.85 foot February 9 and 10, 1915 (discharge, 0.25 million gallons per day, or 0.37 second-foot).

Minimum stage recorded during year 1.05 feet February 26 to March 2 (discharge, 0.8 million gallons per day, or 1.2 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—The entire low flow of the North Fork is diverted immediately below confluence of the right and left branches, and is impounded in Wahiawa reservoir for sugar-cane irrigation on Waialua Agricultural Co.'s plantation.

ACCURACY.—Records July 1 to March 11 good; March 12 to June 30, fair.

Discharge measurements of left branch of North Fork of Kaukonahua Stream near Wahiawa, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Aug. 2	2.25	58	37	Feb. 1	1.26	4.72	3.1
Oct. 3	1.46	8.68	5.6	Apr. 2	1.39	9.93	6.4
Dec. 1	1.52	11.8	7.6	June 2	1.87	39.0	25

Daily discharge, in million gallons, of left branch of North Fork of Kaukonahua Stream near Wahiawa, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	9.0	28	12	9.0	14	10	12	2.6	0.8	8.8	8.8	19
2	7.9	34	12	6.8	10	58	10	4.8	.8	10	6.5	27
3	15	15	5.8	5.8	9.0	21	23	4.8	1.5	17	6.5	13
4	15	21	4.8	5.8	38	34	15	3.2	5.8	6.5	12	7.5
5	9.0	15	4.8	4.8	23	12	19	2.6	2.6	6.5	8.8	8.8
6	6.8	15	4.0	4.8	19	12	9.0	2.0	2.0	5.5	6.5	21
7	4.8	26	4.8	4.8	34	28	7.9	2.0	1.5	4.6	12	15
8	4.0	15	4.0	4.0	28	12	5.8	2.0	1.5	5.5	6.5	40
9	4.0	14	7.9	4.0	23	9.0	5.8	2.0	12	13	5.5	48
10	4.0	9.0	4.8	4.0	34	10	42	2.0	2.0	4.6	6.5	13
11	4.0	10	4.8	3.2	17	7.9	9.0	1.5	34	21	30	21
12	10	10	15	9.0	12	7.9	6.8	1.5	70	10	7.5	10
13	14	12	4.8	5.8	10	14	5.8	4.8	24	17	10	10
14	9.0	76	4.0	5.8	10	7.9	4.8	2.6	40	148	17	7.5
15	4.0	34	4.0	6.8	15	6.8	4.8	1.5	19	30	13	17
16	26	14	4.8	9.0	9.0	6.8	10	1.5	15	36	13	13
17	86	28	7.9	21	50	9.0	9.0	1.5	12	24	12	7.5
18	38	15	6.8	26	46	67	4.8	3.2	8.8	15	74	10
19	14	17	9.0	19	14	81	5.8	2.0	52	12	70	6.5
20	15	15	4.8	17	10	14	12	1.5	40	10	27	5.5
21	19	12	6.8	12	9.0	10	4.8	1.5	24	8.8	13	5.5
22	9.0	9.0	23	10	7.9	14	4.0	1.5	13	21	10	4.6
23	6.8	7.9	15	14	7.9	23	4.0	1.0	12	17	24	4.6
24	6.8	6.8	10	21	7.9	21	12	1.0	24	13	10	3.8
25	10	6.8	34	28	10	9.0	4.8	1.0	99	8.8	8.8	3.8
26	7.9	6.8	34	12	26	7.9	21	.8	52	7.5	7.5	3.8
27	21	6.8	23	28	12	6.8	6.8	.8	15	6.5	7.5	3.2
28	12	5.8	14	58	28	10	4.0	.8	13	13	7.5	5.5
29	6.8	4.8	12	34	14	21	4.0	.....	15	40	7.5	3.2
30	9.0	5.8	7.9	42	14	9.0	3.2	.....	8.8	12	17	3.2
31	19	7.9	.....	19	.....	6.8	2.6	.....	7.5	.....	40	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1 to Mar. 11, well defined; Mar. 12 to May 19 and May 20 to June 30, fairly well defined. Discharge Mar. 24–28 and Apr. 2–4 determined by comparison with records obtained on right branch.

Digitized by Google

Monthly discharge of left branch of North Fork of Kaukonahua Stream near Wahiawa, Oahu, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	86	4.0	13.8	21.4	427	1,310
August	76	4.8	16.2	25.1	503	1,540
September	34	4.0	10.4	16.1	310	958
October	58	3.2	14.7	22.7	454	1,400
November	50	7.9	18.7	28.9	562	1,720
December	81	6.8	18.3	28.3	567	1,740
January	42	2.6	9.47	14.7	294	901
February	4.8	.8	2.07	3.20	58	178
March	99	.8	20.3	31.4	629	1,930
April	148	4.6	18.4	28.5	553	1,690
May	74	5.5	16.3	25.2	506	1,550
June	48	3.2	12.0	18.6	362	1,100
The year	148	.8	14.3	22.1	5,220	16,000

SOUTH FORK OF KAUKONAHUA STREAM ABOVE UNITED STATES ARMY RESERVOIR, NEAR WAHIAWA, OAHU.[1]

LOCATION.—About one-eighth mile above United States Army ditch intake, 5 miles by trail above United States Army reservoir, and 10 miles east of Wahiawa by road to reservoir and trail along ditch.

RECORDS AVAILABLE.—June 18, 1913, to April 5, 1917. Station discontinued on account of backwater from new dam.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable at gage.

CHANNEL AND CONTROL.—Channel in vicinity of gage is straight and has been cleared of boulders; banks steep; flow is confined past the gage. Natural control at head of long riffle has been improved for low-water stages by construction of a low rock-fill dam.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.5 feet at 3 a. m. March 9 (discharge, approximately 600 million gallons per day, or 928 second-feet); minimum stage recorded, 1.25 feet February and March (discharge, 0.8 million gallons per day, or 1.2 second-feet).

Maximum stage recorded during period of record, 7.05 feet 11 p. m. November 20, 1913 (estimated discharge, 900 million gallons per day, or 1,390 second-feet by extension of rating curve); minimum daily discharge, March, 1915 (0.15 million gallons per day, or 0.25 second-foot).

DIVERSIONS.—None above gage. United States Army diverts all the low-water flow one-eighth of a mile below station.

REGULATION.—None.

UTILIZATION.—Low-water flow past this station is diverted one-eighth of a mile down stream into United States Army ditch, and impounded in United States Army storage reservoir of 21 million gallons capacity (64 acre-feet), 5 miles downstream, and carried thence by pipe line for water supply for cantonment at Castner. Records show amount of water available for additional water-supply for Castner. Discharge from South Fork is impounded in Wahiawa reservoir for sugar-cane irrigation on Waialua Plantation.

ACCURACY.—Rating curve well defined for low and medium stages. Gage height of record continuous. Records good below 50 million gallons per day and fair above that limit.

[1] Called South Fork of Kaukonahua stream near Wahiawa, Oahu, in Water-Supply Paper 373.

Digitized by Google

Discharge measurements of South Fork of Kaukonahua Stream, above United States Army reservoir, near Wahiawa, Oahu, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.
Sept. 7	1.62	9.4	6.1
Nov. 13	1.59	9.37	6.1

Daily discharge, in million gallons, of South Fork of Kaukonahua Stream above United States Army reservoir, near Wahiawa, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	9.0	64	13	6.0	9.0	11	7.5	2.8	0.8	4.8
2	7.5	44	15	6.0	7.5	84	13	4.8	.8	3.5
3	9.0	28	6.0	4.8	7.5	22	20	3.5	1.0	7.5
4	9.0	38	6.0	3.5	38	31	9.0	2.8	6.0	6.0
5	7.5	17	3.5	2.8	34	11	9.0	2.8	2.0	7.5
6	4.8	34	3.5	2.8	17	11	9.0	2.0	1.0	.....
7	3.5	17	6.0	3.5	20	31	6.0	2.0	1.0	.....
8	3.5	17	3.5	2.8	11	11	4.8	2.0	1.0	.....
9	3.5	13	3.5	2.0	11	9.0	6.0	2.0	17	.....
10	3.5	9.0	3.5	2.0	17	9.0	52	2.0	2.0	.....
11	3.5	9.0	3.5	2.0	9.0	6.0	11	2.0	9.0	.....
12	7.5	15	11	9.0	7.5	4.8	7.5	2.0	84	.....
13	13	11	3.5	3.5	6.0	17	6.0	2.8	22	.....
14	6.0	28	3.5	2.0	6.0	6.0	6.0	4.8	34	.....
15	3.5	31	3.5	2.0	11	4.8	4.8	2.0	15	.....
16	22	9.0	3.5	2.8	6.0	4.8	13	2.0	13	.....
17	44	25	2.8	15	48	13	11	2.0	11	.....
18	15	20	6.0	20	44	52	4.8	3.5	7.5	.....
19	7.5	15	7.5	11	11	60	6.0	3.5	56	.....
20	7.5	20	3.5	6.0	9.0	15	13	2.0	44	.....
21	9.0	17	4.8	6.0	7.5	15	4.8	2.0	17	.....
22	6.0	11	13	4.8	6.0	17	3.5	1.5	9.0	.....
23	4.8	9.0	13	7.5	6.0	28	3.5	1.0	6.0	.....
24	3.5	7.5	11	7.5	6.0	25	9.0	1.0	4.8	.....
25	4.8	6.0	17	20	4.8	11	3.5	1.0	17	.....
26	6.0	6.0	22	9.0	13	11	22	.8	15	.....
27	11	9.0	13	11	7.5	13	6.0	.8	3.5	.....
28	9.0	7.5	9.0	41	28	34	3.5	.8	4.8	.....
29	3.5	6.0	7.5	15	17	15	3.5	.....	17	.....
30	13	6.0	6.0	11	11	9.0	2.8	.....	4.8	.....
31	34	20	.....	9.0	.....	6.0	2.8	.....	3.5	.....

NOTE.—Discharge determined from rating curve well defined below 50 million gallons per day.

Monthly discharge of South Fork of Kaukonahua Stream, near Wahiawa, Oahu, above United States Army reservoir, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	44	3.5	9.51	14.7	295	905
August	64	6.0	18.4	28.5	569	1,750
September	22	2.8	7.60	11.8	228	700
October	41	2.0	8.11	12.5	251	772
November	48	4.8	14.5	22.4	436	1,340
December	84	4.8	19.3	29.9	597	1,840
January	52	2.8	9.17	14.2	284	872
February	4.8	.8	2.22	3.43	62	191
March	84	.8	13.9	21.5	430	1,320
April 1–5	7.5	3.5	5.86	9.07	29	90
The period	.....	.....	.....	.....	3,180	9,780

Digitized by Google

SOUTH FORK OF KAUKONAHUA STREAM BELOW UNITED STATES ARMY RESERVOIR, NEAR WAHIAWA, OAHU.

LOCATION.—About 600 feet upstream from highway bridge on road from Castner to United States Army reservoir, about one-fourth mile above gulch entering from northeast, 2½ miles east of Castner, and 2 miles southeast of Wahiawa.

RECORDS AVAILABLE.—July 23, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable directly over concrete control 50 feet downstream from gage.

CHANNEL AND CONTROL.—Reinforced concrete slab 26 feet long, extending from bank to bank; 4 feet wide, with rectangular low-water section 7.5 feet wide near left bank, to confine extreme low flow. Downstream side of concrete slab protected from undermining by apron of discarded fence posts. Banks high. Bed composed of gravel; channel straight and fairly smooth in vicinity of gaging station.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 10.35 feet at 7 a. m., August 5, 1914 (discharge, about 1,400 million gallons per day, or 2,170 second-feet, estimated by extension of rating curve); minimum daily discharge, March and June, 1915, and March and June, 1916 (1.0 million gallons per day, or 1.5 second-feet).

DIVERSIONS.—United States Army ditch diverts water from stream near headwaters.

REGULATION.—Practically none.

UTILIZATION.—Water diverted at about 1,130 feet above sea level by the United States Army ditch is impounded in United States Army reservoir and carried by pipe line to the cantonment of Castner for water supply. An additional supply is pumped into this pipe line during periods of extreme low water from the stream just below the highway bridge below the gaging station. Wahiawa reservoir, into which the stream empties, supplies water for sugar-cane irrigation on Waialua plantation.

ACCURACY.—Discharge ascertained from well-defined rating curve and a continuous record of gage height. Below 120 million gallons per day records good.

Discharge measurements of South Fork of Kaukonahua Stream below United States Army reservoir, near Wahiawa, Oahu, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 7	H. A. R. Austin	1.38	36.2	23
Dec. 5	do	1.17	24	16
Feb. 27	do	.50	3.1	2.0
Mar. 14	do	1.96	134	86
Apr. 14	do	2.21	144	93
May 18	R. D. Klise	1.66	57	37

Digitized by Google

Daily discharge, in million gallons, of South Fork of Kaukonahua Stream below United States Army reservoir, near Wahiawa, Oahu, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	14	96	17	7.8	14	14	12	6.8	1.6	14	10	10
2	12	70	19	8.9	12	114	19	10	1.6	11	7.8	12
3	14	38	10	5.8	10	38	28	8.9	1.6	10	19	14
4	14	34	10	5.8	55	42	14	5.8	4.9	7.8	12	7.8
5	12	19	7.8	4.9	90	16	14	5.8	4.9	7.8	14	8.9
6	7.8	23	7.8	4.9	31	14	14	4.0	2.6	6.8	5.8	23
7	6.8	28	16	5.8	38	114	10	4.0	2.1	5.8	4.9	11
8	5.8	19	8.9	2.6	19	26	11	4.0	2.1	10	4.0	10
9	7.8	17	11	3.3	17	14	11	4.0	21	23	3.3	14
10	6.8	16	11	4.9	23	14	147	4.0	7.8	8.9	3.3	8.9
11	5.8	17	8.9	3.3	14	10	23	4.0	8.9	16	5.8	19
12	8.9	23	14	8.9	12	19	14	4.0	133	16	4.9	10
13	17	19	8.9	10	11	12	12	5.8	31	7.8	6.8	8.9
14	11	28	6.8	5.8	10	10	12	8.9	50	42	23	6.8
15	8.9	38	5.8	5.8	11	7.8	11	4.0	23	16	12	11
16	34	16	5.8	5.8	12	7.8	31	4.0	17	21	12	16
17	75	34	4.9	21	42	19	19	4.0	17	14	16	6.8
18	21	38	7.8	28	108	75	12	6.8	16	10	60	6.8
19	14	26	17	19	17	85	12	6.8	120	8.9	96	5.8
20	12	46	8.9	11	12	23	42	4.0	182	7.8	42	4.9
21	12	23	8.9	11	11	23	12	4.0	28	8.9	14	4.9
22	10	17	19	10	11	26	11	2.6	17	12	11	4.0
23	6.8	14	17	12	10	38	10	1.6	12	10	10	4.0
24	6.8	12	14	11	11	34	16	1.6	11	10	8.9	3.3
25	8.9	11	19	28	12	16	10	1.6	19	4.9	8.9	3.3
26	7.8	11	28	12	19	16	28	1.6	26	4.0	7.8	2.6
27	16	14	14	12	11	19	14	1.6	11	4.0	6.8	2.6
28	12	12	14	70	38	50	10	1.6	12	5.8	6.8	4.0
29	7.8	11	10	38	16	23	8.9	.....	23	28	5.8	3.3
30	46	10	7.8	19	42	14	7.8	.....	12	11	7.8	2.6
31	46	26	.....	16	.....	10	6.8	.....	10	.....	19	.....

NOTE.—Discharge determined from rating curve well defined below 120 million gallons per day. Discharge July 1–7, Dec. 4 and 5, 9 and 10, 14–31, Jan. 1–6, and Feb. 8–26 determined by comparison with records obtained at station above United States Army reservoir.

Monthly discharge of South Fork of Kaukonahua Stream below United States Army reservoir, near Wahiawa, Oahu, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	75	5.8	15.8	24.4	489	1,500
August	96	10	26.0	40.2	806	2,470
September	28	4.9	12.0	18.6	359	1,100
October	70	2.6	13.3	20.6	412	1,270
November	108	10	24.6	38.1	739	2,260
December	114	7.8	30.4	47.0	944	2,890
January	147	6.8	19.4	30.0	602	1,850
February	10	1.6	4.49	6.95	126	386
March	182	1.6	26.7	41.3	829	2,540
April	42	4.0	12.1	18.7	363	1,110
May	96	3.3	15.1	23.4	469	1,440
June	23	2.6	8.34	12.9	250	788
The year	182	1.6	17.5	27.1	6,390	19,600

Digitized by Google

MISCELLANEOUS MEASUREMENTS.

Measurements of streams and ditches on the island of Oahu at points other than regular gaging stations are listed below:

Miscellaneous measurements on Oahu for the year ending June 30, 1917.

Date.	Stream.	Locality.	Gage height (feet).	Discharge.	
				Second-feet.	Million gallons per day.
Feb. 12	Punaluu	Elevation 800 feet, near Punaluu		4.00	a 2.59
13	do	do		3.65	a 2.36
14	do	do		4.89	a 3.16
15	do	do		4.12	a 2.66
June 11	Waihoi (north fork)	Elevation 560 feet, near Punaluu		3.5	2.3
11	Waihoi (south fork)	do		1.4	0.9
July 13	East Manoa ditch	100 feet below intake, Manoa Valley	0.93	2.1	1.4
Aug. 29	do	do	1.25	1.9	1.2
Sept. 29	do	do	1.32	1.2	.8

a Total of 4 branches.

ISLAND OF MAUI.

SOUTH WAIEHU STREAM NEAR WAILUKU, MAUI.

LOCATION.—Previous to January 18, 1916, 300 feet above intake of South Waiehu ditch, about 3 miles west of Wailuku. On January 18, 1916, the gage was washed out and station was reestablished April 25, 1916, 500 feet downstream.

RECORDS AVAILABLE.—March 19, 1913, to March 31, 1917, when station was discontinued.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENT.—Made by wading.

CHANNEL AND CONTROL.—One channel at all stages; straight for 45 feet above gage; bed of stream very rough and steep; banks high and covered with vegetation. Control composed of boulders and gravel; shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 6 feet at 5 p. m. January 9, 1916 (discharge, computed from extension of rating curve, approximately 150 million gallons per day, or 232 second-feet); minimum stage recorded, 0.5 foot July, 1913 (discharge, 1.5 million gallons per day, or 2.3 second-feet).

DIVERSIONS.—A small taro ditch diverts about 0.1 second-foot above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane and taro.

ACCURACY.—Gage read twice daily. Records poor, as gage-height record is believed to be unreliable.

Discharge measurements of South Waiehu Stream near Wailuku, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons. per day.
July 24	0.89	6.6	4.3	Dec. 13	0.83	6.22	4.0
Aug. 19	.89	6.1	4.0	Jan. 26	.87	5.18	3.3
Sept. 15	.87	6.95	4.5	Mar. 17	.70	4.34	2.8
Oct. 16	.79	5.41	3.5	18	.83	9.24	6.0

Digitized by Google

Monthly discharge of South Waiehu Stream near Wailuku, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	7.7	5.0	5.28	8.17	164	502
August	6.3	5.0	5.45	8.43	169	518
September	7.0	4.5	5.48	8.48	164	505
October	9.1	4.0	5.13	7.94	159	488
November	7.7	4.0	4.95	7.66	149	456
December	9.1	4.0	4.88	7.55	151	464
January	4.5	4.0	4.06	6.28	126	386
February	5.0	4.0	4.25	6.58	119	365
March	17	4.0	4.61	7.13	143	439

NOTE.—Discharge determined from poorly defined rating curve.

NORTH WAIEHU DITCH NEAR WAILUKU, MAUI.

LOCATION.—About 4 miles by road and trail northwest of Wailuku; one-quarter of a mile below intake.

RECORDS AVAILABLE.—April 25, 1916, to June 30, 1917. Also from December 1, 1910, to July 8, 1912, at old location a short distance below present site.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Channel about 3.5 feet wide cut in earth and gravel; control not well defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 1.55 feet December 23–25, 1916 (discharge, approximately 11 million gallons per day, or 17 second-feet); water occasionally shut off.

DIVERSIONS.—None above station; ditch diverts water from North Waiehu Stream.

REGULATION.—By headgates.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Gage read twice daily. Record good for discharge below 6 million gallons per day.

Discharge measurements of North Waiehu ditch near Wailuku, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 24	0.80	7.5	4.9	Jan 26	0.68	5.09	3.3
Aug. 12	.82	6.7	4.3	Feb. 16	.72	5.30	3.4
Sept 15	.73	5.6	3.6	Mar. 24	.65	4.57	3.0
Dec. 13	.71	5.24	3.4				

Digitized by Google

Daily discharge, in million gallons, of North Waiehu ditch near Wailuku, Maui, for the year ending June 30, 1916.

Date.	Apr.	May.	June.	Date.	Apr.	May.	June.	Date.	Apr.	May.	June.
1	.....	4.0	4.9	11	.....	4.0	5.4	21	.....	4.4	4.9
2	.....	4.0	4.9	12	.....	4.0	5.4	22	.....	4.4	4.9
3	.....	4.0	4.9	13	.....	4.0	4.9	23	.....	4.4	4.9
4	.....	4.0	4.9	14	.....	4.0	4.9	24	.....	4.4	5.4
5	.....	4.0	4.9	15	.....	4.0	4.9	25	.....	4.4	4.9
6	.....	4.0	4.9	16	.....	4.0	5.4	26	4.0	4.4	4.9
7	.....	4.0	5.4	17	.....	4.0	5.4	27	4.0	4.4	4.9
8	.....	4.0	5.4	18	.....	4.0	5.4	28	4.0	4.4	4.9
9	.....	4.0	5.4	19	.....	4.0	5.4	29	4.0	4.4	4.9
10	.....	4.0	5.4	20	.....	4.0	5.4	30	4.0	4.9	4.9
								31	.....	4.9	.....

Daily discharge, in million gallons, of North Waiehu ditch near Wailuku, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	4.9	4.9	3.8	3.4	3.4	3.0	2.2	3.4	3.4	3.4	4.2	3.4
2	4.9	6.0	3.8	3.4	3.4	3.0	3.0	3.4	3.4	3.4	3.4	3.4
3	4.9	3.0	4.2	3.4	3.4	3.0	3.4	3.4	3.4	3.4	3.4	3.4
4	5.4	4.2	4.2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
5	5.4	4.2	4.2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.0
6	5.4	4.2	4.2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.0
7	4.9	4.2	3.4	3.4	3.4	3.4	3.0	3.4	3.4	3.4	3.4	3.0
8	4.9	4.2	3.4	3.4	3.0	3.4	3.0	3.4	3.4	3.4	3.4	3.4
9	4.9	4.2	3.4	3.4	3.4	3.4	3.0	3.8	3.4	3.4	3.4	3.4
10	5.4	4.2	4.2	3.4	3.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4
11	4.9	4.2	3.4	3.4	3.0	3.0	3.4	3.8	3.4	3.4	3.4	3.4
12	4.9	4.2	3.4	3.4	3.0	3.4	3.4	3.8	3.4	3.4	3.4	3.4
13	4.9	4.2	3.4	3.4	3.0	4.2	3.4	3.4	3.4	3.4	3.4	3.4
14	4.9	4.6	3.4	3.4	3.0	4.2	3.4	3.4	4.2	3.4	3.4	3.4
15	4.9	4.6	3.4	3.4	3.0	3.8	3.0	3.4	3.4	3.4	3.4	3.4
16	4.9	4.2	3.4	3.4	3.8	2.2	3.0	3.4	3.4	3.4	3.4	3.4
17	5.4	4.2	3.4	3.4	3.8	2.2	3.0	3.4	3.4	3.4	3.4	3.4
18	4.9	4.2	3.4	3.4	3.4	1.9	3.0	1.3	3.8	3.4	3.8	3.4
19	5.4	4.2	3.8	3.4	3.4	1.9	3.0	1.3	3.0	3.4	3.4	3.4
20	5.4	4.2	3.4	3.4	3.4	1.9	3.0	2.2	3.8	3.4	3.4	3.4
21	4.9	3.8	3.4	3.4	3.0	3.0	3.0	3.4	3.8	3.4	3.4	3.4
22	4.9	3.8	3.4	3.4	3.4	3.4	3.0	3.0	3.4	3.4	3.4	3.4
23	4.9	3.8	3.4	3.4	3.4	11	3.0	3.0	3.4	3.4	3.8	3.0
24	4.9	3.8	3.4	3.4	3.4	11	3.0	3.0	3.4	3.4	3.4	3.0
25	4.9	3.8	3.4	3.4	3.4	11	3.0	3.4	3.4	3.4	3.4	3.0
26	4.9	3.8	3.4	3.4	3.4	3.4	3.0	3.0	3.4	2.6	3.4	3.0
27	3.5	3.8	3.4	3.4	3.4	3.0	3.0	3.4	3.4	1.6	3.4	3.4
28	4.9	3.8	3.4	3.4	3.8	3.0	3.0	3.4	3.8	3.4	3.4	3.4
29	4.9	3.8	3.4	3.4	3.4	3.0	3.4	.....	3.8	3.4	3.4	3.4
30	4.9	3.8	3.4	3.4	3.4	3.0	3.4	.....	3.8	3.4	3.4	3.0
31	4.9	3.8	.....	3.4	.....	3.0	3.4	.....	3.8	.....	3.4	.....

NOTE.—Discharge determined from rating curves well defined below 5 million gallons per day, applicable Apr. 26 to Aug. 2, 1916, and Aug. 3, 1916, to June 30, 1917.

Monthly discharge of North Waiehu ditch near Wailuku, Maui, for year ending June 30, 1916.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
April 26-31	4.0	4.0	4.00	6.19	20	61
May	4.9	4.0	4.17	6.45	129	397
June	5.4	4.9	5.10	7.89	153	470
The period	5.4	4.0	4.58	7.09	302	928

Digitized by Google

Monthly discharge of North Waiehu ditch near Wailuku, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	5.4	3.5	4.97	7.69	154	473
August	6.0	3.0	4.13	6.39	128	393
September	4.2	3.4	3.57	5.52	107	329
October	3 4	3.4	3.40	5.26	105	323
November	3.8	3.0	3.33	5.15	100	307
December	11.0	1.9	3.85	5.96	119	366
January	3.4	2.2	3.13	4.84	97	298
February	3.8	1.3	3.19	4.94	89	274
March	4.2	3.0	3.50	5.42	109	333
April	3.4	1.6	3.31	5.12	99	305
May	4.2	3.4	3.45	5.34	107	328
June	3.4	3.0	3.29	5.09	99	303
The year	11.0	1.3	3.60	5.57	1,310	4,030

WAIHEE STREAM NEAR WAIHEE, MAUI.

LOCATION.—About 300 feet above intake of Waihee canal, 3 miles west of Waihee, and 7 miles northwest of Wailuku.

RECORDS AVAILABLE.—April 1, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder installed January 15, 1916, replacing Barrett & Lawrence water-stage recorder. Datum raised 2.0 feet August 18, 1915.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 250 feet below gage.

CHANNEL AND CONTROL.—Channel at gage is a pool at foot of low waterfall; banks mostly of solid rock, steep and high. Control composed of boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 9 feet (new datum), estimated gage height of flood of January 18, 1916; no estimate of discharge possible; minimum stage recorded, 2.59 feet August 5, 1913 (discharge, 21 million gallons per day, or 32 second-feet).

Minimum stage recorded during year, 2.25 feet March 21 (discharge, 23 million gallons per day, or 36 second-feet).

DIVERSIONS.—None above station.

REGULATION.—Natural flow of stream is increased by development tunnels near headwaters.

UTILIZATION.—Irrigation of sugar cane and taro.

ACCURACY.—Records fair for low and medium stages. There were several changes in control during year and good rating curves were not developed, but frequent discharge measurements give fair rating curves for ordinary stages.

Digitized by Google

Discharge measurements of Waihee Stream near Waihee, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 18	H. A. R. Austin	2.42	84	54
Aug. 19	do	2.40	94	61
Sept. 16	do	2.32	62	40
Oct. 14	do	2.24	57	37
Dec. 13	do	2.47	90	58
Jan. 14	do	2.26	59	38
Feb. 17	do	2.16	47	30
Mar. 17	do	2.38	48	31
18	do	3.03	164	106
Apr. 21	do	2.37	52.3	34
May 19	do	2.32	51.1	33
June 19	C. T. Bailey	2.28	48.9	32

Daily discharge, in million gallons, of Waihee Stream near Waihee, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	58	75	75	69	58	42	42	38	33	47	58	38
2	52	102	63	52	52	102	42	33	33	52	42	58
3	58	95	47	42	42	204	47	33	52	30	42	33
4	58	58	42	42	42	82	69	33	42	38	38	38
5	75	52	38	38	110	42	47	33	33	33	33	33
6	52	42	47	38	82	42	42	33	33	26	33	52
7	52	42	63	38	47	38	42	33	30	26	33	42
8	47	52	47	38	42	42	38	33	52	25	33	88
9	47	42	38	38	47	63	38	33	110	26	33	95
10	58	47	47	38	42	177	52	33	38	26	33	52
11	63	58	42	38	42	47	58	33	82	38	42	69
12	52	63	42	52	38	52	42	33	58	30	38	38
13	58	69	42	42	38	82	38	33	47	42	33	33
14	52	224	42	38	38	102	38	58	44	52	38	33
15	58	102	63	38	58	58	38	33	41	38	38	30
16	63	63	42	38	38	69	38	33	37	30	33	30
17	95	69	38	58	95	82	38	30	33	38	42	30
18	58	58	38	42	42	52	38	38	134	30	63	42
19	88	63	69	38	38	88	38	42	42	38	52	30
20	52	63	42	38	38	58	42	33	33	45	52	30
21	52	63	47	38	38	110	38	33	23	52	52	30
22	47	63	58	52	42	118	33	30	30	33	52	58
23	42	58	69	58	42	284	33	30	26	33	110	33
24	42	58	63	42	47	95	33	30	26	30	75	30
25	47	52	69	38	42	63	33	30	63	26	47	30
26	82	63	52	102	47	52	42	30	47	26	38	26
27	88	58	69	75	47	63	38	33	26	26	38	38
28	63	58	47	63	126	88	38	52	26	88	38	38
29	47	52	47	52	63	52	42	.....	30	244	38	42
30	42	52	42	58	47	42	38	.....	30	186	42	33
31	95	75	.....	38	.....	42	38	.....	38	.....	38	.....

NOTE.—Discharge determined from poorly-defined rating curves applicable as follows: July 1 to Aug. 14, 1916, and Sept. 1, 1916, to Mar. 9, 1917; Aug. 15–31, 1916; Mar. 10 to Apr. 30, 1917; May 1 to June 30, 1917. Discharge interpolated Mar. 14–16 and estimated by comparison with records of neighboring streams June 21–30.

Digitized by Google

Monthly discharge of Waihee Stream near Waihee, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	95	42	59.5	92.1	1,840	5,660
August	224	42	67.5	104	2,090	6,420
September	75	38	51.0	78.9	1,530	4,700
October	102	38	47.5	73.5	1,470	4,520
November	126	38	52.3	80.9	1,570	4,820
December	284	38	81.7	126	2,530	7,770
January	69	33	41.1	63.6	1,270	3,910
February	58	30	34.6	53.5	969	2,970
March	134	23	44.3	68.5	1,370	4,210
April	244	26	48.5	75	1,460	4,470
May	110	33	44.4	68.7	1,380	4,220
June	95	26	41.7	64.5	1,250	3,840
The year	284	23	51.3	79.4	18,700	57,500

HONOKAHAU STREAM NEAR HONOKAHAU, MAUI.

LOCATION.—1,000 feet above intake of Honokahau ditch, about 6 miles southeast of Honokahau.

RECORDS AVAILABLE.—March 6, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 400 feet below gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet below gage, but makes sharp bend 50 feet above gage; right bank slopes gently; left bank is vertical wall of rock. Control composed of large boulders; seldom shifts.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 8.25 feet at 7.30 a. m., January 18, 1916 (discharge computed from extension of rating curve, approximately 1,900 million gallons per day, or 2,940 second-feet); minimum stage recorded, 1.00 foot October 31, 1913, and October 6, 1915 (discharge, 10 million gallons per day, or 15.5 second-feet).

Maximum stage recorded during year, 6.35 feet at 11.45 p. m. March 8 (discharge approximately 1,000 million gallons per day, or 1,550 second-feet); minimum stage recorded, 1.6 feet June 26 (discharge, 11 million gallons per day, or 17 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Low flow of stream all diverted by Honokahau ditch for irrigation of sugar cane and for power development.

ACCURACY.—Records based on rating curves well defined for ordinary stages and continuous gage-height record; good for all stages below 60 million gallons per day; fair for higher stages.

Digitized by Google

Discharge measurements of Honokahau Stream near Honokahau, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 26	H. A. R. Austin	2.52	95	61
Oct. 24	do	1.80	27.6	18
Dec. 15	do	1.93	35.5	23
Jan. 13	R. C. Rice	1.86	29	19
Mar. 26	H. A. R. Austin	1.91	33	21
May 24	do	2.20	55	36
June 26	C. T. Bailey	1.62	18.8	12

Daily discharge, in million gallons, of Honokahau Stream near Honokahau, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	27	52	52	38	41	20	21	17	16	25	30	19
2	27	77	52	27	38	82	21	17	16	36	19	40
3	30	68	22	18	32	149	23	17	30	17	17	16
4	24	35	20	18	24	64	36	17	28	23	16	16
5	38	27	20	16	95	20	23	17	17	19	16	14
6	24	22	24	16	64	18	21	17	17	14	16	23
7	24	20	52	16	30	18	21	17	16	14	14	23
8	22	24	38	16	24	18	21	17	21	14	14	43
9	20	22	20	18	22	35	19	17	33	14	16	43
10	30	24	27	16	20	163	25	17	16	14	14	25
11	35	38	30	16	27	30	30	17	46	30	21	36
12	27	35	24	20	20	24	25	17	33	19	17	16
13	32	38	20	22	20	35	19	17	25	23	14	14
14	30	240	18	18	18	68	19	30	23	43	16	14
15	32	77	32	18	30	30	19	17	21	23	19	14
16	41	35	20	20	44	41	19	17	19	17	14	12
17	82	38	16	32	95	64	21	16	16	25	19	12
18	35	32	20	24	27	30	19	17	58	17	30	19
19	52	35	48	22	20	64	19	30	21	14	23	14
20	24	35	20	22	16	44	23	16	16	23	23	12
21	24	35	22	16	16	82	21	16	14	25	23	12
22	20	35	32	24	16	90	21	16	14	17	21	25
23	18	32	32	41	16	360	21	16	16	16	58	14
24	18	32	38	22	24	62	19	16	19	14	46	12
25	20	27	44	22	22	33	21	14	43	14	19	12
26	44	35	27	68	35	25	25	14	30	14	16	11
27	68	32	32	68	32	33	21	14	16	12	16	16
28	41	32	27	35	100	58	21	36	17	36	16	16
29	24	27	27	38	41	25	23	.....	25	128	21	17
30	24	27	24	48	24	21	23	.....	21	98	16	14
31	82	44	.....	22	.....	21	19	.....	30	.....	19	.....

NOTE.—Discharge determined from rating curves well defined below 60 million gallons per day, applicable July 1 to Dec. 23 and Dec. 24 to June 30. Discharge Aug. 12 to Sept. 1, Dec. 21 to Jan. 7, Jan. 10 and 11, Feb. 11–16, Mar. 14–16, and May 16–21 determined by comparison with records of flow of Waihee Stream.

Digitized by Google

Monthly discharge of Honokahau Stream near Honokahau, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	82	18	33.5	51.8	1,040	3,190
August	240	20	43.0	66.5	1,330	4,090
September	52	16	29.3	45.3	880	2,700
October	68	16	26.4	40.8	817	2,500
November	100	16	34.4	53.2	1,030	3,170
December	360	18	58.9	91.1	1,830	5,600
January	36	19	21.9	33.9	679	2,080
February	36	14	18.1	28.0	506	1,560
March	58	14	23.6	36.5	733	2,250
April	128	12	26.6	41.2	798	2,450
May	58	14	20.6	31.9	639	1,960
June	43	11	19.1	29.6	574	1,760
The year	360	11	29.7	46.0	10,900	33,300

HONOLUA STREAM NEAR HONOKAHAU, MAUI.

LOCATION.—300 feet above Honokahau ditch crossing, about 2 miles south of Honokahau.

RECORDS AVAILABLE.—March 12, 1913, to June 30, 1917.

GAGE.—Vertical staff on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below gage. Stream bed very rough and on steep grade; right bank high and nearly vertical; left bank high with gentle slope. Control composed of large boulders; shifts during floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.2 feet at 6 p. m. January 9, 1916 (discharge, computed from extension of rating curve, approximately 200 million gallons per day, or 309 second-feet); minimum stage recorded, 0.25 foot October 23 and 24, 1913 (discharge, 0.15 million gallons per day, or 0.25 second-feet).

Minimum stage recorded during year, 0.45 foot frequently (discharge, 0.3 million gallons per day, or 0.46 second-foot).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Ordfnary flow is diverted by Honokahau ditch for irrigation of sugar cane.

ACCURACY.—Discharge determined from rating curves fairly well defined between 1 and 10 million gallons per day, and a reliable gage-height record of two readings daily. Records fair except for very low stages for which they may be considerably in error because of the small amount of water involved.

Discharge measurements of Honolua Stream near Honokahau, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 26	1.00	1.4	0.9	Mar. 26	1.07	3.7	2.4
Sept. 10	1.04	2.15	1.4	May 24	1.42	13.4	8.7
Dec. 15	1.30	5.8	3.7				

Digitized by Google

Daily discharge, in million gallons, of Honolua Stream near Honokahau, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.0	5.1	3.6	2.0	2.4	0.8	3.5	0.7	0.6	0.7	6.0	0.4
2	2.0	5.1	7.9	1.4	2.0	2.0	2.8	.5	.4	2.3	3.5	.7
3	2.0	6.8	1.4	.8	2.0	4.4	3.5	.4	1.8	.6	2.3	.4
4	2.0	6.0	.8	.8	1.6	5.1	7.1	.4	4.2	.4	1.5	.4
5	2.4	2.0	.7	.6	3.6	2.4	6.0	.4	.7	.8	.8	.3
6	1.6	1.6	.8	.6	4.4	1.6	4.2	.4	.4	.4	.8	.7
7	1.4	1.1	6.0	.5	3.6	1.4	2.3	.3	.3	.4	.5	1.2
8	1.1	1.1	3.0	.5	1.6	1.4	1.8	.3	.3	.3	.4	4.2
9	1.0	1.0	.8	.5	1.1	2.0	1.2	.3	3.5	.3	.4	5.1
10	1.4	1.0	1.1	.4	1.0	6.8	1.5	.3	.8	.4	.4	4.2
11	2.0	2.4	.8	.4	1.1	3.6	7.1	.3	1.8	.6	.4	5.1
12	2.0	2.0	1.0	.4	.8	2.0	4.2	.3	2.8	.6	.5	.6
13	1.4	3.0	1.0	.8	.7	1.6	1.2	.3	1.8	.6	.4	.4
14	2.0	6.8	.7	.5	.5	9.0	1.2	1.5	2.8	1.0	.4	.4
15	2.0	6.0	.5	.5	.5	3.0	1.0	1.0	.8	.8	.5	.4
16	2.4	2.0	1.6	.5	3.0	2.4	.8	.3	.6	.4	.4	.3
17	3.0	2.0	.8	.8	4.4	4.4	.8	.3	.5	.5	.5	.3
18	2.4	1.0	.7	.6	1.6	3.0	.7	.3	1.8	.4	2.3	.4
19	2.4	3.0	4.4	.6	.8	2.4	.7	2.8	1.5	.3	1.0	.3
20	2.0	3.0	2.0	.8	.7	2.4	.8	.5	1.2	.5	1.0	.3
21	1.6	2.4	1.1	.5	.5	3.0	.8	.4	.6	.6	1.8	.3
22	1.1	3.0	1.6	.8	.4	3.6	.7	.3	.4	1.5	.5	1.0
23	1.1	1.1	4.4	2.4	.4	6.8	.6	.3	.3	.4	7.1	.4
24	1.0	1.0	3.0	1.1	.5	7.1	.5	.3	.3	.6	8.2	.3
25	1.0	1.6	3.0	.7	1.0	5.1	.4	.3	.7	.3	1.2	.3
26	1.4	1.6	2.4	1.4	1.0	4.2	1.2	.3	3.5	.3	.4	.3
27	2.4	1.1	3.0	3.6	1.6	6.0	.8	.3	.8	.3	.4	.3
28	2.4	1.0	1.4	2.4	4.4	8.2	.7	2.3	.6	.4	.4	.3
29	2.4	.8	.8	1.4	3.0	5.1	.7	.....	.5	36	.4	.4
30	2.4	.7	.8	3.0	1.1	4.2	2.8	.....	.5	32	.3	.4
31	4.4	1.6	.....	1.0	.....	4.2	1.2	.....	.8	.....	.4	.....

NOTE.—Discharge determined from rating curves fairly well defined between 1 and 10 million gallons per day, applicable July 1 to Dec. 23 and Dec. 24 to June 30.

Monthly discharge of Honolua Stream near Honokahau, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	4.4	1.0	1.93	2.99	60	184
August	6.8	.7	2.51	3.88	78	239
September	7.9	.5	2.04	3.16	61	188
October	3.6	.4	1.04	1.61	32	99
November	4.4	.4	1.71	2.65	51	157
December	9.0	.8	3.85	5.96	119	366
January	7.1	.4	2.03	3.14	63	193
February	2.8	.3	.58	.90	16	50
March	4.2	.3	1.21	1.87	38	115
April	36	.3	2.82	4.36	85	260
May	8.2	.3	1.45	2.24	45	138
June	5.1	.3	1.00	1.55	30	92
The year	36	.3	1.00	2.88	678	2,080

HONOKAWAI STREAM NEAR LAHAINA, MAUI.

LOCATION.—500 feet below confluence with Amalu Stream, about 8 miles northeast of Lahaina.

RECORDS AVAILABLE.—May 13, 1913, to March 15, 1917, when gage was washed out.

GAGE.—Vertical staff on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 150 feet below gage.

CHANNEL AND CONTROL.—One channel at all stages; filled with large boulders and very rough; very narrow at gage. Control a rock ledge; probably permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.9 feet at 3 p. m. January 8, 1916 (discharge computed from extension of rating curve, approximately 150 million gallons per day, or 232 second-feet); stream occasionally dry.

Minimum stage recorded during year, 1.0 foot frequently (discharge, 0.2 million gallons per day, or 0.3 second-foot).

DIVERSIONS.—Most of the natural flow is diverted into Honokawai ditch half a mile above gage.

REGULATION.—Natural flow of stream is increased by a development tunnel a short distance above intake of Honokawai ditch.

UTILIZATION.—Irrigation of sugar cane and taro.

ACCURACY.—Discharge ascertained from rating curve well defined below 40 million gallons per day and a gage-height record of two readings daily. Records fair.

Daily discharge, in million gallons, of Honokawai Stream near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	1.2	9.0	2.3	1.0	1.2	0.4	0.6	0.3	0.3
2	.4	17	5.8	.7	2.3	3.9	.6	.3	.3
3	1.4	12	2.6	.4	1.4	8.4	1.4	.3	1.2
4	.7	2.6	.6	.4	.7	12	3.4	.3	2.6
5	2.0	1.4	.4	.3	41	1.2	3.0	.3	.6
6	.6	.7	.7	.3	19	.3	1.7	.3	.6
7	.4	.7	16	.6	2.6	.2	.7	.3	.3
8	.3	.7	10	.6	2.0	.3	.7	.3	.3
9	.2	.7	.7	.6	.7	.3	.4	.3	1.4
10	1.7	2.0	1.4	.6	.3	24	.4	.2	.4
11	3.0	6.4	1.2	.6	5.3	2.3	2.3	.2	.3
12	1.4	5.3	.7	.6	.7	.6	1.7	.2	1.0
13	1.4	2.6	.4	.4	.3	.4	.6	.2	1.2
14	1.4	5.3	.4	.4	.3	2.0	.4	4.4	7.1
15	1.2	1.0	.3	.4	3.0	.6	.3	.4	11
16	3.4	.4	2.0	.3	32	1.7	.2	.3	.....
17	10	3.0	.4	1.7	8.4	4.8	.2	.3	.....
18	2.0	.7	.2	3.9	1.0	2.6	.2	.3	.....
19	2.3	8.4	21	.7	.3	9.7	.2	2.0	.....
20	.7	4.8	1.7	.7	.3	3.9	.3	.6	.....
21	1.2	1.4	.7	.3	.2	25	.2	.4	.....
22	.4	2.6	.7	.6	.2	28	.2	.3	.....
23	.2	.7	5.8	2.6	.2	30	.2	.3	.....
24	.2	.6	9.7	.4	.2	12	.2	.3	.....
25	.2	.6	2.3	1.7	1.0	4.4	.2	.3	.....
26	1.0	1.2	1.2	7.8	24	1.7	6.4	.3	.....
27	11	1.0	.7	7.8	1.0	.6	.4	.3	.....
28	8.4	2.3	1.0	2.0	4.8	11	.4	3.9	.....
29	1.7	.6	.6	1.0	.7	2.6	.4	.....	.....
30	.7	.4	.6	3.0	.7	.6	1.0	.....	.....
31	24	3.0	.....	.7	.....	.4	.2	.....	.....

NOTE.—Discharge determined from a rating curve well defined below 40 million gallons per day.

Monthly discharge of Honokawai Stream near Lahaina, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	24	0.2	2.73	4.22	85	260
August	17	.4	3.20	4.95	99	304
September	21	.2	3.07	4.75	92	283
October	7.8	.3	1.39	2.15	43	132
November	41	.2	5.19	8.03	156	478
December	30	.2	6.32	9.78	196	601
January	6.4	.2	.94	1.45	29	89
February	4.4	.2	.64	.99	18	55
March 1-15	11	.3	1.91	2.95	29	88
The period	.....	.....	.....	.....	747	2,290

Digitized by Google

HONOKAWAI DITCH NEAR LAHAINA, MAUI.

LOCATION.—250 feet below junction with Amalu wooden flume, 1,000 feet below intake, 2 miles above Pioneer Mill Co.'s power house, and about 7 miles northeast of Lahaina.

RECORDS AVAILABLE.—July 1, 1912, to June 30, 1917.

GAGE.—A graduated rod which the observer places in center of flume at each reading.

DISCHARGE MEASUREMENTS.—Made in flume near gage.

CHANNEL AND CONTROL.—Semicircular galvanized iron flume 3 feet in diameter; straight for 100 feet above and below gage; flume clean and uniform in section and grade. Stage-discharge relation stable.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 1.67 feet August 12, 193 (discharge, 15 million gallons per day, or 23 second-feet); minimum stage recorded, 0.80 foot May 15, 1913 (discharge, 2.4 million gallons per day, or 3.8 second-feet).

Maximum stage recorded during year, 1.45 feet July 11, 17, 31, and September 19 and 24 (discharge, 9.0 million gallons per day, or 14 second-feet); minimum stage recorded, 0.95 foot June 27 (discharge, 3.6 million gallons per day, or 5.6 second-feet).

DIVERSIONS.—Ditch diverts all low-water flow from Honokawai and Amalu streams.

REGULATION.—Flow controlled by head gates.

UTILIZATION.—Power development and irrigation of sugar cane.

ACCURACY.—Gage read twice daily. Records are fair for all stages. Great care has to be taken in making measurements on account of slope of flume, but a fairly good rating curve has been developed. On account of the uniform conditions the extension of the rating curve probably good.

Daily discharge, in million gallons, of Honokawai ditch near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	6.6	8.4	7.2	7.2	7.2	6.0	5.5	4.5	5.0	6.6	6.0	6.0
2	6.6	8.4	7.2	7.2	7.2	7.8	5.5	4.5	4.5	6.0	5.0	7.2
3	6.6	8.4	7.2	6.0	7.2	7.2	6.0	4.0	6.0	6.0	5.0	5.5
4	6.0	7.2	6.0	6.0	6.6	7.2	7.2	4.0	7.2	5.0	4.5	5.0
5	7.2	7.2	6.0	5.5	8.4	5.5	6.0	4.0	5.0	6.0	5.0	4.5
6	6.0	6.0	6.0	5.5	7.8	5.5	6.0	4.0	5.0	5.0	4.0	4.5
7	5.5	6.0	8.4	5.5	6.6	5.0	5.5	4.0	4.5	5.0	5.0	6.0
8	5.5	6.0	7.8	5.5	6.6	5.5	5.5	4.0	4.5	5.0	4.5	7.2
9	5.0	6.0	6.6	5.5	6.0	5.5	5.0	4.0	6.0	5.0	4.0	6.0
10	6.6	7.2	6.6	5.5	5.5	7.8	5.0	4.0	5.0	5.0	4.5	6.0
11	7.2	7.2	6.6	5.5	7.2	7.2	6.0	4.0	4.5	7.8	5.0	6.0
12	7.2	7.8	6.6	5.5	6.0	6.0	6.0	4.0	6.0	6.0	6.0	5.0
13	6.6	7.2	6.0	6.0	5.5	6.0	5.0	4.0	6.0	7.2	6.0	4.5
14	7.8	7.2	6.0	6.0	5.5	7.2	5.0	6.6	7.2	7.2	5.0	4.0
15	7.2	6.6	6.0	6.0	7.2	6.0	4.5	4.5	7.2	7.2	5.5	4.0
16	8.4	6.0	7.2	5.5	7.8	6.6	4.5	4.0	.....	6.0	5.0	4.0
17	8.4	7.2	6.0	7.2	7.8	7.2	4.5	4.0	.....	6.0	5.0	4.0
18	7.2	6.0	5.5	7.8	7.2	7.2	4.5	4.0	.....	6.6	6.0	5.5
19	8.4	7.8	8.4	7.2	6.0	7.8	4.5	6.0	.....	5.5	5.0	5.0
20	6.6	7.2	7.2	7.2	5.0	7.2	4.5	5.0	.....	6.0	5.0	4.5
21	7.2	6.0	6.6	5.5	5.0	7.8	4.5	4.5	.....	6.0	6.0	4.0
22	5.0	7.2	6.6	6.0	5.0	7.8	4.5	4.0	.....	5.0	5.0	6.0
23	5.0	6.0	8.4	7.8	5.0	7.2	4.5	4.0	.....	6.0	6.0	4.0
24	5.0	6.0	8.4	6.6	5.0	7.2	4.5	4.0	5.5	6.0	6.0	4.0
25	5.0	6.0	7.2	7.2	6.0	7.2	4.5	4.0	5.5	6.0	5.0	4.0
26	6.0	5.5	6.6	8.4	8.4	6.6	7.2	4.0	5.5	7.2	4.0	3.6
27	8.4	6.0	6.0	7.8	6.0	6.0	5.0	4.0	5.0	5.5	4.0	3.6
28	8.4	7.2	6.6	7.2	7.8	7.2	4.5	7.2	5.5	5.0	4.0	4.0
29	7.2	6.0	6.0	6.0	6.0	6.0	4.5	.....	7.2	5.0	5.0	4.0
30	6.6	6.0	6.0	7.8	6.0	6.0	6.0	.....	6.6	5.0	5.0	4.0
31	8.4	7.2	.....	6.0	.....	5.5	4.5	.....	7.2	.....	5.0	.....

NOTE.—Discharge determined from fairly well defined rating curve. No record Mar. 16–23.

Digitized by Google

Monthly discharge of Honokawai ditch near Lahaina, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	8.4	5.0	6.74	10.4	209	641
August	8.4	5.5	6.78	10.5	210	645
September	8.4	5.5	6.76	10.5	203	622
October	8.4	5.5	6.44	9.96	200	613
November	8.4	5.0	6.48	10.0	194	597
December	7.8	5.0	6.64	10.3	206	632
January	7.2	4.5	5.17	8.00	160	492
February	7.2	4.0	4.39	6.79	123	377
April	7.8	5.0	5.89	9.11	177	542
May	6.0	4.0	5.03	7.78	156	479
June	7.2	3.6	4.85	7.50	146	447

KAHOMA STREAM NEAR LAHAINA, MAUI.

LOCATION.—About 125 feet above intake of Pioneer Mill Co.'s upper ditch, 3½ miles east of Lahaina.

RECORDS AVAILABLE.—August 3, 1911, to June 30, 1917.

GAGE.—Vertical staff on left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—Channel at gage is a pool at foot of rapids; right bank high and wooded; left bank a vertical wall of rock. Control composed of large and small boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 8.5 feet at 7 a. m. January 18, 1916 (discharge, estimated from extension of rating curve, 700 million gallons per day, or 1,080 second-feet); maximum stage recorded during year, 4.4 feet at 7 a. m. March 18 (discharge, approximately 250 million gallons per day, or 387 second-feet); minimum stage recorded, 1.2 feet frequently (discharge, 3.5 million gallons per day, or 5.4 second-feet).

DIVERSIONS.—None above station at present. Before November 24, 1914, the minimum flow of the stream and water from Kahoma development tunnel was diverted above station; since that date all water passes the gage.

REGULATION.—Natural flow of the stream is largely increased by a development tunnel about 300 feet above station.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Gage read twice daily. Records fair for ordinary stages. Extension of rating curve not confirmed by measurements; estimates above 20 million gallons per day roughly approximate only.

Discharge measurements of Kahoma Stream near Lahaina, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Oct. 25	1.33	8.8	5.7	Jan. 23	1.20	5.0	3.3
25	1.42	13.2	8.5				

Digitized by Google

Daily discharge, in million gallons, of Kahoma Stream near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	6.4	49	6.4	4.4	6.4	4.4	3.5	4.4	4.4	5.3	13	5.3
2	6.4	13	17	4.4	6.4	21	4.4	3.5	4.4	17	5.3	31
3	5.3	15	5.3	4.4	24	12	7.6	3.5	10	13	4.4	4.4
4	4.4	7.6	5.3	4.4	90	15	19	3.5	6.4	5.3	4.4	4.4
5	5.3	7.6	5.3	4.4	28	4.4	17	3.5	4.4	5.3	4.4	3.5
6	4.4	6.4	5.3	4.4	10	3.5	19	3.5	4.4	4.4	3.5	4.4
7	3.5	4.4	26	4.4	8.8	3.5	5.3	3.5	4.4	4.4	4.4	4.4
8	3.5	4.4	17	4.4	3.5	3.5	3.5	3.5	4.4	4.4	4.4	3.5
9	3.5	5.3	5.3	4.4	3.5	3.5	3.5	3.5	4.4	4.4	4.4	4.4
10	7.6	6.4	7.6	4.4	10	37	3.5	3.5	4.4	4.4	4.4	3.5
11	6.4	15	5.3	4.4	4.4	6.4	6.4	3.5	15	56	15	4.4
12	5.3	34	6.4	4.4	3.5	15	5.3	3.5	5.3	5.3	6.4	3.5
13	8.8	17	5.3	4.4	8.8	3.5	3.5	3.5	4.4	4.4	4.4	3.5
14	6.4	17	4.4	4.4	3.5	5.3	3.5	8.8	12	4.4	5.3	3.5
15	15	7.6	4.4	5.3	3.5	4.4	3.5	4.4	19	6.4	6.4	3.5
16	13	4.4	4.4	19	40	26	3.5	4.4	6.4	7.6	4.4	3.5
17	21	6.4	4.4	6.4	26	112	3.5	4.4	4.4	31	24	3.5
18	7.6	10	5.3	10	6.4	10	3.5	4.4	127	13	6.4	5.3
19	19	15	12	5.3	4.4	12	3.5	6.4	6.4	4.4	4.4	3.5
20	5.3	8.8	7.6	5.3	3.5	8.8	4.4	4.4	5.3	6.4	4.4	3.5
21	6.4	6.4	5.3	4.4	3.5	60	4.4	4.4	4.4	5.3	6.4	3.5
22	4.4	6.4	5.3	5.3	3.5	74	4.4	4.4	4.4	4.4	6.4	3.5
23	4.4	5.3	7.6	6.4	3.5	70	3.5	4.4	8.8	4.4	21	3.5
24	4.4	5.3	15	4.4	3.5	12	3.5	4.4	6.4	4.4	7.6	12
25	4.4	4.4	6.4	5.3	5.3	6.4	3.5	4.4	17	4.4	4.4	3.5
26	6.4	5.3	5.3	13	28	5.3	3.5	4.4	6.4	4.4	3.5	3.5
27	6.4	6.4	5.3	28	21	3.5	4.4	4.4	4.4	3.5	4.4	3.5
28	10	6.4	4.4	5.3	49	13	5.3	4.4	6.4	3.5	4.4	3.5
29	6.4	5.3	4.4	4.4	6.4	7.6	5.3	.....	19	17	17	3.5
30	7.6	5.3	4.4	10	5.3	4.4	5.3	.....	5.3	43	4.4	4.4
31	17	5.3	.....	6.4	.....	3.5	3.5	.....	7.6	.....	4.4	.....

NOTE.—Discharge determined from a rating curve well defined between 2 and 10 million gallons per day.

Monthly discharge of Kahoma Stream near Lahaina, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	21	3.5	7.61	11.8	236	724
August	49	4.4	10.2	15.8	316	970
September	26	4.4	7.45	11.5	223	686
October	28	4.4	6.64	10.3	206	632
November	90	3.5	14.1	21.8	424	1,300
December	112	3.5	18.4	28.5	571	1,760
January	19	3.5	5.60	8.66	174	533
February	8.8	3.5	4.24	6.56	119	364
March	127	4.4	11.2	17.3	347	1,070
April	56	3.5	10.0	15.5	301	921
May	24	3.5	7.02	10.9	218	668
June	31	3.5	5.03	7.78	151	463
The year	127	3.5	9.00	13.9	3,290	10,100

Digitized by Google

KAHOMA DEVELOPMENT TUNNEL NEAR LAHAINA, MAUI.

LOCATION.—At portal of the lower of two development tunnels of Pioneer Mill Co., 3½ miles east of Lahaina.

RECORDS AVAILABLE.—August 1, 1911, to June 30, 1917.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—A 4-foot sharp-crested weir with end contractions measures discharge from development tunnel and amount diverted from stream by small pipe; measurements checked by current meter.

CHANNEL AND CONTROL.—Deep pool at weir confined by rock and concrete walls.

EXTREMES OF DISCHARGE.—Maximum discharge during period of record, 6.5 million gallons per day, or 10 second-feet, August, 1911; minimum discharge, 1.7 million gallons per day, or 2.6 second-feet.

DIVERSIONS.—Small amount diverted from Kahoma Stream also passes over weir.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Records good. No velocity of approach; good weir. Gage read twice daily.

Daily discharge, in million gallons, of Kahoma development tunnel near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1	3.4	4.3	4.4	4.1	3.6	3.1	2.9	2.9	3.5	3.6	3.0	2.6
2	3.4	4.3	4.4	4.1	3.6	3.1	2.8	2.9	3.5	3.6	3.0	2.6
3	3.4	4.3	4.4	4.1	3.6	3.1	2.8	3.0	3.5	3.6	3.0	2.6
4	3.4	4.3	4.4	4.1	3.6	3.1	2.8	3.0	3.5	3.6	2.9	2.6
5	3.4	4.4	4.4	4.1	3.6	3.1	2.8	3.0	3.5	3.6	2.9	2.6
6	3.5	4.4	4.4	4.1	3.5	3.1	2.8	3.0	3.5	3.6	2.9	2.6
7	3.5	4.4	4.4	4.1	3.5	3.1	2.8	3.0	3.5	3.6	2.9	2.6
8	3.5	4.4	4.4	4.1	3.5	3.1	2.8	3.0	3.5	3.6	2.8	2.6
9	3.6	4.4	4.4	4.1	3.5	3.1	2.8	3.0	3.6	3.6	2.8	2.6
10	3.7	4.4	4.4	4.1	3.5	3.1	2.8	3.1	3.6	3.5	2.8	2.6
11	3.7	4.4	4.4	4.0	3.5	3.1	2.8	3.1	3.6	3.5	2.8	2.6
12	3.8	4.4	4.4	4.0	3.5	3.0	2.8	3.1	3.6	3.5	2.8	2.6
13	3.8	4.4	4.4	4.0	3.5	3.0	2.8	3.2	3.6	3.4	2.8	2.5
14	3.9	4.4	4.4	4.0	3.5	3.0	2.8	3.2	3.6	3.4	2.8	2.5
15	3.9	4.4	4.3	4.0	3.5	3.0	2.8	3.2	3.6	3.4	2.8	2.5
16	3.9	4.4	4.3	4.0	3.5	3.0	2.8	3.2	3.6	3.4	2.8	2.5
17	3.9	4.4	4.3	4.0	3.5	3.0	2.8	3.2	3.6	3.3	2.8	2.5
18	4.0	4.4	4.3	4.0	3.5	3.0	2.8	3.2	3.6	3.3	2.8	2.5
19	4.0	4.4	4.3	3.9	3.5	2.9	2.8	3.3	3.6	3.3	2.8	2.5
20	4.0	4.4	4.3	3.9	3.5	2.9	2.8	3.3	3.6	3.3	2.8	2.5
21	4.1	4.4	4.2	3.8	3.4	2.9	2.8	3.3	3.6	3.2	2.8	2.4
22	4.1	4.4	4.2	3.8	3.4	2.9	2.8	3.4	3.6	3.2	2.8	2.4
23	4.1	4.4	4.2	3.8	3.3	2.9	2.8	3.4	3.6	3.2	2.7	2.4
24	4.2	4.4	4.2	3.8	3.3	2.9	2.8	3.4	3.6	3.2	2.7	2.4
25	4.2	4.4	4.2	3.7	3.2	2.9	2.8	3.4	3.6	3.1	2.7	2.4
26	4.2	4.4	4.2	3.7	3.2	2.9	2.8	3.4	3.6	3.1	2.7	2.4
27	4.3	4.4	4.1	3.7	3.2	2.9	2.8	3.5	3.6	3.1	2.7	2.3
28	4.3	4.4	4.1	3.7	3.2	2.9	2.8	3.5	3.6	3.1	2.7	2.3
29	4.3	4.4	4.1	3.7	3.1	2.9	2.8	.....	3.6	3.1	2.7	2.3
30	4.3	4.4	4.1	3.7	3.1	2.9	2.9	.....	3.6	3.0	2.7	2.3
31	4.3	4.4	.....	3.7	.....	2.9	2.9	.....	3.6	.....	2.7	.....

Digitized by Google

Monthly discharge of Kahoma development tunnel near Lahaina, Maui for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	4.3	3.4	3.87	5.99	120	368
August	4.4	4.3	4.39	6.79	136	418
September	4.4	4.1	4.30	6.65	129	396
October	4.1	3.7	3.93	6.08	122	374
November	3.6	3.1	3.43	5.31	103	316
December	3.1	2.9	2.99	4.63	93	284
January	2.9	2.8	2.81	4.35	87	267
February	3.5	2.9	3.19	4.94	89	274
March	3.6	3.5	3.57	5.52	111	340
April	3.6	3.0	3.37	5.21	101	320
May	3.0	2.7	2.80	4.33	87	266
June	2.6	2.3	2.49	3.85	75	237
The year	4.4	2.3	3.43	5.31	1,250	3,860

LAHAINALUNA STREAM ABOVE PIPE-LINE INTAKE, NEAR LAHAINA, MAUI.

LOCATION.—200 feet above intake of pipe line supplying Lahaina and Lahainaluna school, about 2½ miles northeast of Lahaina.

RECORDS AVAILABLE.—February 29, 1916, to June 30, 1917.

GAGE.—Gurley printing water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—One channel at all stages; fairly straight in vicinity of gage; filled with large boulders; banks steep and high. Control composed of large boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 3.3 feet at 11.30 p. m. December 21, 1916 (discharge, approximately 300 million gallons per day, or 464 second-feet); minimum stage recorded, 0.95 foot March 22, 1917 (discharge, 3.4 million gallons per day, or 5.3 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Domestic supply, power development, and irrigation of sugar cane.

ACCURACY.—Records based on continuous record of gage height and fairly well-defined rating curve; fair for low and medium stages. Extension of rating curve above 15 million gallons per day not based on discharge measurements. Discharge record prior to July 1, 1916, not reliable owing to faulty working of water-stage recorder.

Discharge measurements of Lahainaluna Stream above pipe-line intake, near Lahaina, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 25	H. A. R. Austin	1.30	9.2	6.0
Aug. 17	do	1.39	13	8.3
Sept. 9	do	1.25	8.75	5.7
Oct. 23	do	1.49	20.4	13
Dec. 14	do	1.31	8.2	5.3
Jan. 22	do	1.26	8.5	5.5
Feb. 10	do	1.23	8.1	5.2
Mar. 27	do	1.13	7.1	4.6
Apr. 20	do	1.27	8.85	5.7
June 20	C. T. Bailey	1.10	5.82	3.8

Digitized by Google

Daily discharge, in million gallons, of Lahainaluna Stream above pipe-line intake, near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	17	13	8.6	5.4	7.3	4.9	6.0	5.4	4.9	4.6	6.0	4.6
2	11	17	17	5.4	8.6	5.4	6.0	5.4	4.9	5.4	4.9	11
3	11	17	5.4	4.9	7.3	21	6.0	5.4	13	5.4	4.6	4.6
4	8.6	6.0	5.4	4.9	6.0	21	6.0	5.4	7.3	4.6	4.6	4.6
5	11	6.0	5.4	4.9	37	7.3	13	5.4	5.4	4.9	4.6	4.6
6	7.3	5.4	5.4	4.9	21	5.4	11	5.4	5.4	4.6	4.6	4.6
7	7.3	5.4	11	4.9	5.4	5.4	7.3	5.4	4.9	4.6	4.6	4.6
8	6.0	5.4	7.3	4.9	5.4	5.4	6.0	5.4	4.9	4.6	4.6	4.6
9	6.0	5.4	5.4	4.9	4.9	5.4	6.0	5.4	4.9	4.6	4.6	4.6
10	6.0	8.6	6.0	4.9	4.9	21	6.0	5.4	4.9	4.9	4.6	4.6
11	6.0	13	7.3	4.9	6.0	11	13	5.4	17	21	5.4	4.6
12	6.0	17	6.0	6.0	4.9	6.0	6.0	5.4	5.4	4.9	4.6	4.2
13	6.0	17	6.0	6.0	4.9	6.0	6.0	5.4	4.9	4.6	4.9	4.2
14	5.4	11	6.0	4.9	4.9	6.0	5.4	8.6	4.9	4.6	4.9	4.2
15	5.4	6.0	6.0	4.9	4.9	5.4	5.4	5.4	5.4	6.0	4.9	4.2
16	6.0	5.4	6.0	6.0	17	26	5.4	4.9	4.9	5.4	4.6	4.2
17	7.3	7.3	6.0	8.6	17	21	5.4	4.9	4.9	8.6	11	4.2
18	6.0	8.6	6.0	6.0	4.9	11	5.4	6.0	26	5.4	4.9	4.6
19	5.4	13	31	6.0	4.6	21	5.4	11	4.9	4.6	4.6	4.2
20	6.0	11	7.3	6.0	4.6	11	6.0	5.4	3.6	5.4	4.6	4.2
21	5.4	5.4	6.0	4.9	4.6	100	5.4	4.9	3.6	4.9	4.9	4.2
22	5.4	6.0	7.3	6.0	4.6	84	5.4	4.9	3.4	4.6	4.9	4.9
23	5.4	5.4	8.6	8.6	4.6	50	5.4	4.9	3.9	4.6	6.0	4.2
24	5.4	5.4	8.6	5.4	5.4	21	5.4	4.9	3.6	4.6	6.0	4.2
25	5.4	5.4	6.0	5.4	4.6	8.6	5.4	4.9	4.2	4.6	4.6	4.2
26	7.3	5.4	5.4	13	4.6	11	5.4	4.9	4.9	4.6	4.6	4.2
27	21	5.4	5.4	7.3	4.6	11	7.3	4.9	4.6	4.9	4.6	4.6
28	11	7.3	5.4	5.4	7.3	17	6.0	4.9	4.6	7.3	4.9	4.6
29	7.3	5.4	4.9	4.9	7.3	7.3	7.3	.....	7.3	17	4.9	4.6
30	8.6	5.4	4.9	13	5.4	6.0	7.3	.....	4.9	11	4.6	4.2
31	43	6.0	.....	5.4	.....	6.0	5.4	.....	4.6	.....	4.6	.....

NOTE.—Discharge determined from rating curve fairly well defined below 15 million gallons per day. Discharge July 1–25, Oct. 11–23, Nov. 26–30, Dec. 1–14, and Dec. 26 to Jan. 4 determined by comparison with records of flow of Ukumehame stream.

Monthly discharge of Lahainaluna Stream above pipe-line intake, near Lahaina, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	43	5.4	8.90	13.8	276	847
August	17	5.4	8.42	13.0	261	801
September	31	4.9	7.57	11.7	227	697
October	13	4.9	6.08	9.41	189	578
November	37	4.6	7.82	12.1	234	720
December	100	4.9	17.7	26.4	548	1,680
January	13	5.4	6.53	10.1	202	621
February	11	4.9	5.56	8.60	156	478
March	26	3.4	6.19	9.58	192	589
April	21	4.6	6.23	9.64	187	574
May	11	4.6	5.05	7.81	157	480
June	11	4.2	4.64	7.18	139	427
The year	100	3.4	7.58	11.7	2,770	8,490

Digitized by Google

KAUAULA STREAM NEAR LAHAINA, MAUI.

LOCATION.—350 feet above Kauaula ditch intake, about 3 miles east of Lahaina.

RECORDS AVAILABLE.—March 7, 1912, to June 30, 1917.

GAGE.—Vertical staff installed April 20, 1916, to replace vertical staff installed April 29, 1913, and washed out January 18, 1916. Old gage was 250 feet above present location.

DISCHARGE MEASUREMENTS.—Made by wading or from foot bridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below station; stream bed composed of boulders and coarse gravel; right bank slopes gently; left bank is of rock and nearly vertical. Control shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.0 feet at 6 a. m. January 9, 1916 (discharge, computed from extension of rating curve, approximately 600 million gallons per day or 928 second-feet); minimum stage recorded, 0.89 foot April, 1914 (discharge, 4.2 million gallons per day, or 6.5 second-feet).

Minimum stage recorded during year, 1.4 feet April, May, and June (discharge, 5.4 million gallons per day, or 8.4 second-feet).

DIVERSIONS.—None above station.

REGULATION.—Natural flow of stream is increased by a development tunnel in mountains above station.

UTILIZATION.—Power development and irrigation of sugar cane.

ACCURACY.—Gage read twice daily. Records poor on account of instability of control.

Discharge measurements of Kauaula Stream near Lahaina, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 27	1.50	14	9.2	Jan. 23	1.44	8.9	5.8
Aug. 18	1.48	12	7.6	Mar. 27	1.43	8.4	5.4
Oct. 23	1.49	12.7	8.2	May 25	1.47	9.0	5.8

Digitized by Google

Daily discharge, in million gallons, of Kauaula Stream near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	9.7	10	7.8	7.8	7.8	7.8	7.4	6.2	5.8	5.8	8.0	5.4
2	9.2	9.7	9.7	7.8	8.3	9.2	7.4	6.2	5.8	5.8	6.2	8.5
3	9.2	11	8.3	7.4	8.3	10	7.4	5.8	6.2	5.8	6.2	5.8
4	9.2	9.7	7.8	7.4	7.8	10	8.4	5.8	6.2	5.4	5.8	5.4
5	9.2	9.2	7.8	7.4	11	8.3	7.4	5.8	6.2	5.5	6.2	5.4
6	8.8	8.8	7.8	7.4	8.8	7.8	7.4	5.8	5.8	5.4	5.8	5.4
7	8.8	8.8	9.2	7.4	8.8	7.8	7.4	5.8	5.8	5.4	5.8	5.4
8	8.8	8.8	8.4	7.4	8.3	8.3	7.0	5.8	5.8	5.4	5.8	5.8
9	8.8	9.2	7.8	7.4	7.8	7.8	7.0	5.8	5.8	5.4	5.4	5.8
10	8.8	9.2	7.8	7.4	7.4	11	7.0	5.8	5.8	5.4	5.4	5.4
11	8.8	9.2	7.8	7.4	7.8	8.8	8.3	5.8	7.4	7.8	5.8	6.6
12	8.8	11	7.8	7.4	7.4	8.3	7.4	5.8	6.6	7.4	5.8	5.8
13	8.8	11	7.8	7.4	7.4	7.8	7.4	5.8	5.8	5.8	5.4	5.4
14	8.8	11	7.8	7.4	7.4	7.8	6.6	6 6	5.8	5.4	6.2	5.4
15	9.2	8.8	7.4	7.4	7.4	8.3	6.6	5.8	5.8	5.8	5.8	5.4
16	9.2	8.3	7.4	7.4	8.8	11	6.6	5.8	5.8	5.4	5.4	5.4
17	13	8.3	7.4	7.8	9.2	9.2	6.6	5.8	5.8	6.6	7.0	5.4
18	9.7	8.3	7.4	8.3	7.8	8.3	6.6	6.2	9.7	6.2	6.2	5.8
19	10	8.3	8.3	7.4	7.4	9.7	6.6	7.0	7.4	5.4	5.8	5.4
20	9.2	8.8	8.3	7.4	7.4	9.2	7.0	5.8	7.4	5.4	5.8	5.4
21	9.2	8.3	7.8	7.4	7.4	15	6.2	5.8	5.8	5.8	6.2	5.4
22	8.8	8.3	7.8	7.8	7.4	20	6.2	6.8	5.5	5.4	6.2	5.4
23	8.8	7.8	8.8	8.4	7.4	16	6.2	5.8	6.2	5.4	6.6	5.4
24	8.8	7.8	8.3	7.4	7.4	12	6.2	5.8	6.6	5.4	8.5	5.4
25	8.8	7.8	8.3	7.4	7.4	8.8	6.2	5.8	6.6	5.4	6.6	5.4
26	9.2	7.8	7.8	8.8	9.7	8.8	6.2	5.8	5.8	5.4	5.8	5.4
27	10	7.8	7.8	8.8	7.8	8.3	6.6	5.8	5.8	5.4	5.8	5.4
28	9.7	7.8	7.4	7.8	11	8.8	7.0	5.8	5.8	5.8	6.6	5.4
29	9.2	8.3	7.4	7.4	8.3	8.3	6.6	.....	7.4	9.5	6.2	5.4
30	8.8	7.8	7.4	7.8	8.3	8.3	6.6	.....	6.2	9.0	6.2	5.4
31	12	7.8	.....	7.4	.....	7.8	6.2	.....	6.2	.....	5.4	.....

NOTE.—Discharge determined from poorly defined rating curves applicable as follows: July 1 to Aug. 4, 1916, Aug. 15 to Dec. 23, 1916, Jan. 21 to Mar. 18, 1917, Apr. 1 to June 30, 1917. Method for shifting channels Dec. 24, 1916, to Jan. 20, 1917, and Mar. 19–31, 1917. Discharge Sept. 8, Oct. 23, Jan. 28 and 30, Feb. 19, Mar. 12, Apr. 5, 12, 17, 18, 29, and 30, May 1, 14, 21, 23, 25, 28–30, and June 2 and 11 was taken from Kauaula ditch record as being more accurate than stream record; all water being diverted.

Monthly discharge of Kauaula Stream near Lahaina, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	13	8.8	9.33	14.4	289	888
August	11	7.8	8.86	13.7	275	843
September	9.7	7.4	7.95	12.3	239	732
October	8.8	7.4	7.63	11.8	236	726
November	11	7.4	8.15	12.6	244	750
December	20	7.8	9.63	14.9	298	916
January	8.4	6.2	6.89	10.7	214	655
February	7.0	5.8	5.91	9.14	166	506
March	9.7	5.5	6.28	9.72	195	597
April	9.5	5.4	5.97	9.24	179	550
May	8.5	5.4	6.13	9.48	190	583
June	8.5	5.4	5.61	8.68	168	516
The year	20	5.4	7.38	11.4	2,690	8,260

KAUAULA DITCH NEAR LAHAINA, MAUI.

LOCATION.—About 100 feet below intake, which is uppermost on the stream, about 3 miles east of Lahaina.

RECORDS AVAILABLE.—October 16, 1911, to June 30, 1917.

Digitized by Google

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made in flume at gage.

CHANNEL AND CONTROL.—Straight wooden flume 3 feet wide.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.58 feet at 6 a. m. Aug. 12 (discharge, 10 million gallons per day, or 15.5 second-feet); maximum stage recorded during period of record, 1.70 feet April 7, 1912 (discharge, 16 million gallons per day, or 24 second-feet); water occasionally turned off.

DIVERSIONS.—Ditch diverts all low flow from Kauaula stream.

REGULATION.—Flow regulated by head gates.

UTILIZATION.—Power development and irrigation of sugar cane.

ACCURACY.—Gage read twice daily. Records fair for all stages.

Discharge measurements of Kauaula ditch near Lahaina, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 27	1.41	14	9.1	Jan. 23	1.03	8.9	5.8
Aug. 18	1.30	12	7.6	Mar. 28	.99	8.4	5.4
Oct. 23	1.38	12.7	8.2	May 25	.90	9.0	5.8

Daily discharge, in million gallons, of Kauaula ditch near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	8.2	8.6	7.6	7.2	7.6	6.2	6.9	5.8	5.2	5.5	8.0	4.8
2	8.6	8.2	9.1	6.9	7.6	8.0	6.9	5.8	4.8	5.5	5.8	8.5
3	7.8	9.4	8.0	6.6	8.0	8.0	6.6	5.5	6.2	5.5	5.3	5.8
4	7.8	9.0	6.9	6.2	6.6	8.4	8.4	5.5	5.2	5.2	5.3	4.8
5	7.8	9.0	6.9	6.2	8.4	7.6	8.0	5.5	6.2	5.5	5.8	4.8
6	8.2	8.2	6.9	6.2	7.6	6.6	7.2	5.5	5.2	5.2	4.4	4.8
7	7.8	7.8	9.1	6.2	7.6	6.6	6.9	5.5	5.2	5.2	4.0	4.4
8	7.4	8.2	8.4	6.2	7.6	7.2	6.9	5.5	5.2	5.2	4.4	5.8
9	7.0	8.2	7.6	6.2	6.2	6.9	6.6	5.5	5.2	4.8	4.0	5.8
10	7.0	8.6	6.9	6.2	6.2	6.6	6.6	5.2	4.8	4.8	4.0	4.8
11	7.8	8.2	6.9	6.2	6.6	7.6	8.0	5.2	6.6	6.6	4.8	6.6
12	7.8	9.8	6.9	5.8	6.2	6.9	7.2	5.2	6.6	7.2	5.3	5.3
13	7.4	8.8	6.9	5.8	5.8	6.6	6.6	5.2	5.5	5.2	4.4	4.4
14	7.8	8.4	6.9	5.8	5.8	6.6	6.2	6.6	5.2	5.2	6.2	4 4
15	8.2	8.8	6.9	5.8	5.8	6.9	6.2	5.2	5.2	5.5	5.8	4.0
16	7.8	7.6	6.6	6.6	7.6	8.0	6.2	5.2	5.2	5.2	4.4	4.0
17	9.0	7.6	6 2	7.2	8.4	7.2	6.2	5.2	5.2	6.6	6.6	4.0
18	8.6	8.0	6.2	8.0	6.9	7.2	6.2	5.8	8.4	6.2	5.8	4.8
19	8.6	8.0	7.6	6.6	6.6	8.0	5.8	6.9	7.2	5.2	4.8	4.0
20	8.6	8.4	6.9	6.2	5.8	8.4	6.9	5.5	7.2	5.2	4.4	4.0
21	8.6	8.0	6.9	6.2	5.5	8.4	5.8	5.5	5.8	5.5	6.2	4.0
22	7.4	7.6	6.9	6.9	5.5	7.6	5.8	5.2	5.5	5.2	6.2	4.0
23	7.4	7.2	8.0	8.4	5.5	7.6	5.8	5.2	6.2	5.2	6.6	4.0
24	7.0	7.2	7.6	6.2	5.8	7.6	5.5	5.2	6.6	5.2	8.5	4.0
25	7.0	7.2	8.0	6.2	5.8	7.6	5.5	5.2	6.6	5.2	6.6	4.0
26	7.0	6.9	6.9	8.0	8.0	8.4	6.2	5.2	5.8	4.8	4.8	3.6
27	9.0	6.9	6.9	8.4	6.6	8.0	6.6	5.2	5.5	3.6	4.8	4.0
28	9.0	7.2	6.6	7.2	8.4	7.6	6.9	5.2	5.5	4.4	6.6	4.0
29	8.2	7.6	6.6	6.2	7.6	8.0	6.6	.....	7.2	9.5	6.2	4.0
30	8.2	6.9	6.6	6.9	7.6	7.6	6.6	.....	5.8	9.0	6.2	4.0
31	8.6	6.9	.....	6.6	.....	7.6	5.8	.....	5.8	.....	4.8	.....

NOTE.—Discharge determined from fairly well defined rating curves applicable as follows: July 1 to Aug. 12, 1916, Aug. 13, 1916, to Apr. 26, 1917, Apr. 27 to June 30, 1917.

Digitized by Google

Monthly discharge of Kauaula ditch near Lahaina, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	9.0	7.0	7.95	12.3	247	756
August	9.8	6.9	8.01	12.4	248	762
September	9.1	6.2	7.21	11.2	216	664
October	8.4	5.8	6.62	10.2	205	630
November	8.4	5.5	6.84	10.6	205	630
December	8.4	6.2	7.47	11.6	232	711
January	8.4	5.5	6.57	10.2	204	625
February	6.9	5.2	5.47	8.46	153	470
March	8.4	4.8	5.86	9.07	182	557
April	9.5	3.6	5.54	8.57	166	510
May	8.5	4.0	5.52	8.54	171	525
June	8.5	3.6	4.65	7.19	139	428
The year	9.8	3.6	6.49	10.0	2,370	7,270

LAUNIUPOKO STREAM NEAR LAHAINA, MAUI.

LOCATION.—About 175 feet above Pioneer Mill Co.'s ditch intake, 1 mile above storage reservoir, and about 5½ miles southeast of Lahaina.

RECORDS AVAILABLE.—July 25, 1911, to June 30, 1917.

GAGE.—Vertical staff on right bank. New datum April 21, 1916.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—One channel at all stages; straight for 50 feet above and below gage; stream bed rough and steep. Control composed of small boulders; shifts during floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.0 feet estimated gage height of flood of January 18, 1916 (determination of discharge not possible); minimum stage recorded, 0.4 foot frequently during 1913–14 (discharge, 0.5 million gallons per day, or 0.75 second-feet).

Minimum stage recorded during year, 0.5 foot frequently (discharge, 0.9 million gallons per day, or 1.4 second-feet).

DIVERSIONS.—None above station.

REGULATION.—Nearly all low-water flow of stream is derived from a development tunnel above station.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Gage read once daily. Records fair for ordinary stages.

Discharge measurements of Launiupoko Stream near Lahaina, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 27	1.05	5.4	3.5	Oct. 23	0.82	1.71	1.1
Aug. 10	.89	2.3	1.5	Jan. 24	.82	1.5	1.0
Sept. 11	.85	2.0	1.3	May 25	.49	1.37	.9

Digitized by Google

Daily discharge, in million gallons, of Launiupoko Stream near Lahaina, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.2	2.2	1.6	1.2	0.9	0.9	1.2	1.6	0.9	0.9	0.9	0.9
2	1.6	2.2	2.2	1.2	1.2	1.2	1.2	1.2	.9	.9	.....	.9
3	1.6	3.4	1.6	1.2	.9	1.2	1.2	1.2	.9	.9	.....	.....
4	1.6	2.8	1.6	1.2	.9	2.8	3.4	1.2	.9	.9	.....	.....
5	1.6	2.8	1.2	.9	5.6	1.2	1.2	1.2	.9	.9	.....	.9
6	1.6	2.8	1.2	.9	1.6	.9	1.2	.9	.9	.9	.....	.....
7	1.6	2.2	1.6	.9	1.2	.9	.9	.9	.9	.9	.....	.....
8	1.6	2.2	1.6	.9	.9	2.8	.9	.9	.9	.9	.9	.....
9	1.6	2.2	1.2	.9	.9	2.8	.9	.9	.9	.9	.....	.9
10	1.6	2.2	1.2	.9	.9	.....	.9	.9	.9	.9	.....	.....
11	1.6	2.2	1.2	.9	.9	1.2	1.6	.9	2.8	1.2	.....	.9
12	1.6	3.4	1.2	.9	.9	.9	1.2	.9	1.2	1.2	.....	.....
13	1.6	3.4	1.2	1.2	.9	.9	1.2	.9	.9	.....	.....	.....
14	1.6	2.8	1.2	1.2	.9	.9	1.2	2.2	.9	.....	.....	.9
15	1.6	2.2	1.2	.9	.9	1.2	.9	.9	.9	.9	.9	.9
16	1.6	2.2	1.2	1.2	.9	1.6	.9	.9	.9	.9	.....	.9
17	3.4	2.2	1.2	1.2	1.6	1.2	.9	.9	.9	.9	.....	.9
18	2.8	1.6	1.2	.9	.9	1.2	.9	.9	11.0	.....	.....	.9
19	2.8	1.6	1.2	.9	.9	.9	.9	4.0	6.4	.....	.....	.....
20	2.2	1.6	1.6	.9	.9	1.2	1.2	1.2	1.2	.9	.....	.9
21	2.2	1.6	1.2	.9	.9	5.6	.9	.9	1.2	.....	.....	.....
22	2.2	1.6	1.2	1.2	.9	5.6	.9	.9	1.2	.....	.....	.....
23	2.2	1.6	1.2	.9	.9	8.1	.9	.9	1.2	.9	.....	.....
24	2.2	1.6	1.2	.9	.9	6.4	.9	.9	1.2	.....	.9	.....
25	2.2	1.6	1.2	1.2	.9	3.4	1.2	.9	1.2	.....	.....	.9
26	2.2	1.6	1.2	.9	.9	2.2	1.6	.9	1.2	.....	.9	.....
27	2.8	1.6	1.2	1.2	.9	2.2	5.6	.9	.9	.....	.9	.9
28	2.2	1.6	1.2	.9	.9	2.2	3.4	.9	.9	.....	.9	.....
29	2.2	1.6	1.2	.9	.9	2.2	2.8	.....	.9	4.0	.9	.9
30	2.2	1.6	1.2	.9	.9	1.6	2.2	.....	.9	2.2	.9.	.9
31	5.6	1.6	.....	1.2	.....	1.6	1.6	.....	.9	.....	.9	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1 to Mar. 18, well defined between 1 and 4 million gallons per day; Mar. 19 to June 30, poorly defined. Gage heights recorded intermittently after Apr. 12.

Monthly discharge of Launiupoko Stream near Lahaina, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	5.6	1.6	2.12	3.28	66	202
August	3.4	1.6	2.12	3.28	66	202
September	2.2	1.2	1.31	2.03	39	121
October	1.2	.9	1.02	1.58	32	97
November	5.6	.9	1.12	1.73	34	103
January	5.6	.9	1.48	2.29	46	141
February	4.0	.9	1.14	1.76	32	98
March	11.0	.9	1.54	2.38	48	147

OLOWALU DITCH NEAR OLOWALU, MAUI.

LOCATION.—425 feet above intake to penstock of hydro electric power station, 1 mile above Olowalu and 7 miles east of Lahaina.

RECORDS AVAILABLE.—July 28, 1916, to June 30, 1917. Replaces old station in tailrace from power house, for which records are available August 12, 1911, to June 30, 1916.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by wading.

Digitized by Google

CHANNEL AND CONTROL.—Channel about 3.5 feet wide cut in earth and rock; straight for 50 feet above and below gage. Control not well defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 0.98 foot at 5.30 a. m. July 31 (discharge, 8.1 million gallons per day, or 12.5 second-feet); minimum stage recorded, 0.3 foot August and April (discharge, 2.8 million gallons per day, or 4.3 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—After passing through power house water is used for irrigation of sugar cane. A small amount is sometimes diverted for irrigation at higher levels and does not pass through power house.

ACCURACY.—Gage read twice daily. Records good for all stages.

Discharge measurements of Olowalu ditch near Olowalu, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 28	0.72	9.3	6.0	Oct. 21	0.48	6.15	4.0
Aug. 18	.53	6.9	4.5	Jan. 26	.67	8.6	5.6
Sept. 9	.68	8.55	5.5	May 23	.57	6.4	4.1

Daily discharge, in million gallons, of Olowalu ditch near Olowalu, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	.....	7.0	5.4	4.6	4.6	4.6	5.0	3.8	3.5	3.2	5.8	4.6
2	.....	6.6	6.2	4.6	4.6	5.0	5.0	3.8	3.5	3.2	6.2	4.6
3	.....	6.2	5.4	4.2	4.6	5.4	5.0	3.5	3.8	3.2	5.8	4.2
4	.....	6.2	5.4	4.2	4.2	5.8	4.6	3.5	3.8	3.5	5.8	3.8
5	.....	5.8	5.0	4.2	5.0	5.8	4.6	3.5	4.6	3.5	5.8	3.8
6	.....	5.4	5.0	4.2	4.6	5.4	4.2	3.5	4.6	3.5	5.8	3.8
7	.....	5.4	5.8	4.2	4.6	5.0	4.2	3.8	4.6	3.5	5.4	3.5
8	.....	5.0	5.4	4.2	4.2	5.8	4.2	3.5	4.2	3.5	5.4	4.2
9	.....	4.6	5.4	4.2	4.2	5.8	4.2	3.5	4.2	3.2	5.0	4.2
10	.....	3.8	5.4	4.2	3.8	6.2	4.2	3.5	4.2	3.2	4.6	4.2
11	.....	4.6	5.0	3.8	3.8	6.2	5.0	3.8	4.6	3.2	4.6	4.2
12	.....	5.4	5.0	4.2	3.8	5.0	5.0	4.6	5.0	3.2	4.6	4.2
13	.....	6.6	5.0	4.6	3.8	5.8	4.6	4.6	4.6	3.2	4.6	3.8
14	.....	7.4	5.0	5.0	3.5	5.4	4.6	4.6	4.6	3.2	4.2	3.8
15	.....	7.4	5.0	4.6	3.8	5.4	4.6	4.2	4.6	2.8	4.2	3.5
16	.....	7.0	4.6	5.0	3.8	5.4	4.2	4.2	4.2	2.8	4.2	3.8
17	.....	5.8	4.6	5.4	5.8	5.0	4.2	4.2	4.6	3.2	4.2	4.2
18	.....	5.0	4.6	5.4	5.8	5.0	4.2	4.6	7.0	3.2	4.2	3.8
19	.....	4.2	5.8	5.0	5.0	.....	4.2	5.4	4.2	3.2	4.2	3.8
20	.....	3.8	5.8	5.0	4.6	5.8	4.6	5.4	.....	3.2	3.5	3.5
21	.....	3.5	5.4	4.6	4.6	6.6	4.6	5.4	3.8	3.2	3.2	3.2
22	.....	3.5	5.0	4.2	4.2	7.0	4.6	5.0	3.8	3.2	3.2	3.2
23	.....	3.2	5.0	4.2	4.2	7.4	4.2	4.6	3.5	2.8	3.5	3.2
24	.....	4.2	5.4	4.6	4.2	7.8	4.2	4.2	3.5	2.8	4.2	3.2
25	.....	4.2	5.4	4.2	4.2	7.4	4.2	4.2	3.5	2.8	3.8	3.5
26	.....	3.5	5.4	5.0	4.2	7.0	4.6	4.2	3.2	2.8	3.8	3.5
27	.....	3.2	5.0	5.4	4.6	7.0	4.6	4.2	3.2	3.8	3.8	3.8
28	5.8	2.8	5.0	4.6	4.6	7.0	5.0	3.8	3.5	4.2	4.6	3.5
29	5.0	3.2	4.6	4.6	4.6	5.8	5.0	.....	3.2	5.4	5.4	3.8
30	4.6	3.8	4.6	4.6	4.6	5.4	4.2	.....	3.2	5.4	5.4	3.5
31	7.8	5.0	.....	4.6	.....	5.4	4.2	.....	3.2	.....	5.0	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 28, 1916, to Mar. 19, 1917, well defined between 3 and 7 million gallons per day; Mar. 21 to June 30, 1917, fairly well defined. Ditch broken Dec. 19 and Mar. 20.

Digitized by Google

Monthly discharge of Olowalu ditch near Olowalu, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
August	7.4	2.8	4.95	7.66	153	471
September	6.2	4.6	5.19	8.03	156	478
October	5.4	3.8	4.56	7.06	141	434
November	5.8	3.5	4.40	6.81	132	405
January	5.0	4.2	4.51	6.98	140	429
February	5.4	3.5	4.18	6.47	117	359
April	5.4	2.8	3.37	5.21	101	310
May	6.2	3.2	4.65	7.19	144	442
June	4.6	3.2	3.80	5.88	114	350

UKUMEHAME STREAM NEAR OLOWALU, MAUI.

LOCATION.—Half a mile above upper ditch intake, 2 miles above Government road at the 14-mile post, and 4 miles by road and trail east of Olowalu.

RECORDS AVAILABLE.—August 14, 1911, to June 30, 1917.

GAGE.—Gurley printing water-stage recorder installed February 20, 1916; replaced vertical staff installed April 23, 1913, 200 feet below present gage and washed out January 18, 1916.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 900 feet below gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 50 feet above and below gage; right bank is steep and high; left bank slopes gradually; very rough stream bed composed of boulders and gravel. Control somewhat shifting.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 9.0 feet estimated gage height of flood of January 18, 1916; no estimate of discharge possible; minimum stage recorded, 0.60 foot October 4 and 5, 1913 (discharge, 2.3 million gallons per day, or 3.6 second-feet).

Maximum stage recorded during year, 4.55 feet at 9 a. m. March 18 (discharge approximately 150 million gallons per day, or 232 second-feet); minimum stage recorded, 0.5 foot April and June (discharge, 4.1 million gallons per day, or 6.3 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Records, July 1, 1916, to January 11, 1917, good; those for remainder of year, fair. Several shifts in control occurred, but frequent discharge measurements gave fair results for ordinary stages.

Digitized by Google

Discharge measurements of Ukumehame Stream near Olowalu, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 28	H. A. R. Austin	0.98	19	12
Aug. 17	do	.90	15	10
Sept. 9	do	.80	11.6	7.5
Oct. 21	do	.72	8.23	5.3
Dec. 16	do	1.01	20.8	13
Jan. 25	do	.84	8.3	5.4
Feb. 10	do	.96	8.6	5.6
12	do	.62	8.0	5.2
Mar. 27	do	.57	7.9	5.1
Apr. 20	do	.58	8.38	5.4
May 23	do	.57	7.84	5.1
June 20	C. T. Bailey	.50	6.33	4.1

Daily discharge, in million gallons, of Ukumehame Stream near Olowalu, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	14	14	10	6.2	6.2	6.2	7.4	5.0	7.4	6.2	8.7	5.0
2	13	14	15	6.2	6.2	7.4	7.4	5.0	7.4	6.2	8.7	5.0
3	13	18	10	6.2	6.2	16	7.4	5.0	8.7	5.0	7.4	5.0
4	12	13	8.7	6.2	6.2	16	7.4	5.0	8.7	5.0	6.2	5.0
5	13	10	8.7	6.2	13	10	7.4	5.0	8.7	5.0	8.7	5.0
6	10	8.7	10	6.2	12	7.4	6.2	5.0	8.7	5.0	7.4	5.0
7	10	8.7	15	6.2	8.7	7.4	6.2	5.0	7.4	5.0	6.2	4.1
8	8.7	7.4	13	6.2	7.4	7.4	6.2	5.0	7.4	5.0	6.2	5.0
9	8.7	7.4	10	6.2	6.2	7.4	6.2	5.0	7.4	5.0	6.2	5.0
10	8.7	7.4	7.4	6.2	6.2	16	8.7	5.0	7.4	5.0	6.2	5.0
11	8.7	7.4	7.4	5.0	6.2	13	20	5.0	10	6.2	6.2	6.2
12	8.7	10	7.4	7.4	6.2	8.7	8.7	5.0	10	5.0	5.0	5.0
13	8.7	12	7.4	6.2	6.2	8.7	8.7	5.0	8.7	5.0	5.0	5.0
14	7.4	15	6.2	6.2	5.0	8.7	7.4	13	8.7	5.0	5.0	4.1
15	7.4	13	6.2	5.0	6.2	7.4	7.4	8.7	7.4	5.0	5.0	4.1
16	8.7	10	6.2	5.0	7.4	12	7.4	8.7	7.4	5.0	5.0	4.1
17	10	8.7	6.2	6.2	12	12	7.4	7.4	7.4	5.0	6.2	4.1
18	8.7	7.4	6.2	6.2	7.4	8.7	7.4	10	27	5.0	5.0	4.1
19	7.4	7.4	8.7	5.0	6.2	8.7	7.4	13	14	5.0	5.0	4.1
20	8.7	7.4	7.4	5.0	6.2	8.7	8.7	10	10	5.0	5.0	4.1
21	7.4	8.7	7.4	5.0	6.2	20	7.4	8.7	8.7	5.0	5.0	4.1
22	7.4	12	6.2	5.0	6.2	22	7.4	8.7	7.4	5.0	5.0	5.0
23	7.4	15	8.7	6.2	6.2	28	7.4	8.7	7.4	5.0	6.2	4.1
24	7.4	12	8.7	5.0	6.2	22	7.4	8.7	6.2	5.0	5.0	4.1
25	7.4	8.7	8.7	5.0	6.2	20	7.4	8.7	6.2	5.0	5.0	4.1
26	8.7	8.7	7.4	8.7	5.0	13	6.2	7.4	6.2	5.0	5.0	4.1
27	13	8.7	7.4	8.7	5.0	13	15	7.4	6.2	4.1	7.4	5.0
28	13	10	7.4	7.4	10	12	14	7.4	5.0	7.4	7.4	5.0
29	10	8.7	6.2	6.2	10	10	16	.....	5.0	18	6.2	4.1
30	8.7	7.4	6.2	6.2	7.4	8.7	8.7	.....	6.2	13	5.0	4.1
31	16	8.7	.....	6.2	.....	8.7	6.2	.....	5.0	.....	5.0	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1, 1916, to Jan. 11, 1917, well defined between 4 and 16 million gallons per day; Feb. 12 to Mar. 18, 1917, and Mar. 19 to June 30, 1917, poorly defined. Shifting-control method used Jan. 12 to Feb. 11. Discharge determined by comparison with record of Lahainaluna Stream Sept. 1–10.

Digitized by Google

Monthly discharge of Ukumehame Stream near Olowalu, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	16	7.4	9.74	15.1	302	927
August	18	7.4	10.2	15.8	316	970
September	15	6.2	8.38	13.0	251	772
October	8.7	5.0	6.09	9.42	189	579
November	13	5.0	7.19	11.1	216	662
December	28	6.2	12.1	18.6	375	1,150
January	20	6.2	8.52	13.2	264	811
February	13	5.0	7.20	11.1	202	619
March	27	5.0	8.36	12.9	259	795
April	18	4.1	5.87	9.08	176	540
May	8.7	5.0	6.02	9.31	186	573
June	6.2	4.1	4.59	7.10	138	423
The year	28	4.1	7.87	12.2	2,870	8,820

WAIKAPU STREAM NEAR WAIKAPU, MAUI.

LOCATION.—300 feet below intake of Palolo ditch, 1½ miles west of Waikapu, and 4 miles by road southwest of Wailuku.

RECORDS AVAILABLE.—December 1, 1910, to June 30, 1917.

GAGE.—Vertical staff on left bank installed April 26, 1916, to replace staff gage at old location 200 feet downstream. Old gage washed out January 7, 1916.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and 25 feet below gage; left bank high and nearly vertical; right bank slopes gently. Control composed of large boulders; fairly permanent between extreme floods.

EXTREMES OF DISCHARGE.—Highest flood on record occurred morning of January 18, 1916, when water reached a height of about 10 feet, datum of old gage; discharge not estimated. Minimum stage recorded, 0.25 foot (old datum) February 26 to March 4, 1914 (discharge, 0.1 million gallons per day, or 0.15 second-foot).

Minimum stage for the year, 1.0 foot May and June (discharge, 0.4 million gallons per day, or 0.6 second-foot).

DIVERSIONS.—Nearly all low-water flow is diverted above station by South Side Waikapu ditch and Palolo ditch.

REGULATION.—Natural flow has been increased by development tunnels near the headwaters.

UTILIZATION.—Flow at low and medium stages is diverted for irrigation of sugar cane.

ACCURACY.—Record fair for low and medium stages; those for high and fluctuating stages roughly approximate only, as gage is read but twice daily.

Discharge measurements of Waikapu Stream near Waikapu, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 24	H. A. R. Austin	0.91	2.9	1.9
Aug. 17	do	.95	3.7	2.4
Sept. 16	do	.78	1.65	1.1
Oct. 14	do	.85	1.28	.74
Jan. 20	do	.83	2.86	1.8
Mar. 24	do	1.33	4.07	2.6
May 26	do	1.02	.59	.38
June 27	C. T. Bailey	1.02	.77	.5

Digitized by Google

Daily discharge, in million gallons, of Waikapu Stream near Waikapu, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	3.6	5.1	2.0	1.2	0.9	0.6	2.0	1.2	0.9	1.2	9.0	0.4
2	3.6	8.0	9.0	1.6	.9	1.6	1.6	1.2	.9	1.2	5.1	.4
3	3.6	10	4.2	1.2	.9	13	1.6	1.2	.9	.9	.9	.4
4	5.1	3.6	3.0	.9	.9	8.0	2.0	.9	1.2	.9	.9	.4
5	6.0	3.0	3.0	.9	8.0	1.2	1.6	.9	1.2	1.2	.9	.4
6	3.6	2.5	2.5	.9	1.6	.9	1.6	.9	.9	.9	.9	.4
7	3.6	2.5	7.0	.9	.9	.9	1.6	.9	.9	.9	.6	.4
8	3.0	2.5	3.0	.9	.9	1.2	1.6	.6	.9	.9	.6	2.0
9	3.0	2.0	3.0	.9	.6	.9	1.2	.6	.9	.9	.6	2.0
10	3.0	2.0	2.0	.9	.6	42	1.2	.9	.9	.9	.6	.9
11	3.6	2.0	2.0	.9	.6	3.0	4.2	.6	1.6	1.2	.6	2.5
12	3.0	3.0	2.0	.9	.6	2.5	1.6	.6	1.2	1.2	.6	.6
13	3.0	7.0	1.6	1.2	.6	1.2	1.2	.9	.9	.9	.6	.6
14	2.5	25	1.6	.9	.6	3.0	1.2	6.0	.9	6.0	.6	.4
15	2.0	7.0	1.6	.9	.6	2.5	1.2	1.2	.9	.9	.6	.4
16	2.0	3.0	1.6	.9	.9	14	1.2	1.2	.9	.9	.6	.4
17	3.6	2.5	.9	1.2	7.0	3.6	.9	1.2	.9	1.2	.6	.4
18	2.5	2.5	.9	.9	1.6	3.0	.9	1.6	220	.9	.9	.4
19	2.5	2.5	2.5	.9	.9	1.6	1.2	2.0	9.0	.9	.9	.4
20	2.0	2.0	3.0	.9	.6	1.2	1.2	1.6	5.1	1.2	.9	.4
21	2.0	2.0	1.2	.9	.6	13	.9	1.6	3.6	1.2	1.2	.4
22	2.0	2.0	1.2	1.2	.6	16	.9	1.2	3.6	.9	1.2	2.5
23	2.0	2.0	2.5	1.2	.6	55	.9	1.2	3.6	.9	1.2	.6
24	2.0	2.0	2.0	.9	.6	19	.9	1.2	8.0	.9	.4	.4
25	2.0	2.0	2.0	.9	.6	22	.9	1.2	1.2	.9	.4	.4
26	2.5	2.5	1.2	3.0	.6	3.6	1.6	1.2	1.2	.9	.4	.4
27	8.0	2.0	1.2	1.6	.6	1.6	2.0	.9	1.2	.9	.6	1.2
28	4.2	2.0	1.2	1.2	4.2	2.0	3.0	1.2	1.2	.9	.4	.9
29	2.5	2.0	.9	.9	2.0	2.0	1.2	.....	1.2	44	.4	.6
30	2.0	2.0	1.2	.9	.9	2.0	1.2	.....	1.2	27	.4	.4
31	16	2.0	.....	.9	.....	1.6	1.2	.....	1.2	.....	.4	.....

NOTE.—Discharge determined from rating curves fairly well defined below 4 million gallons per day, applicable July 1 to Mar. 18 and Mar. 19 to June 30.

Monthly discharge of Waikapu Stream near Waikapu, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	16	2.0	3.55	5.49	110	338
August	25	2.0	3.88	6.00	120	369
September	9.0	.9	2.37	3.67	71	218
October	3.0	.9	1.08	1.67	34	103
November	8.0	.6	1.38	2.14	42	127
December	55	.6	7.86	12.2	244	748
January	4.2	.9	1.47	2.27	46	140
February	6.0	.6	1.28	1.98	36	110
March	220	.9	8.97	13.9	278	853
April	44	.9	3.46	5.35	104	319
May	9.0	.4	1.10	1.70	34	105
June	2.5	.4	.73	1.13	22	67
The year	220	.4	3.12	4.83	1,140	3,500

PALOLO DITCH NEAR WAIKAPU, MAUI.

LOCATION.—200 feet below intake, 1½ miles west of Waikapu, and 5½ miles by road southwest of Wailuku.

RECORDS AVAILABLE.—November 21, 1910, to June 30, 1917.

GAGE.—Vertical staff on left bank.

DISCHARGE MEASUREMENTS.—Made by wading.

Digitized by Google

CHANNEL AND CONTROL.—Channel is cut in earth and soft rock; fairly straight for 50 feet above and below gage; clean and usually free from vegetation. Control a small wooden culvert 1 foot below gage; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.18 feet at 9 a. m. December 26 (discharge, 3.7 million gallons per day, or 5.7 second-feet); maximum stage recorded during period of record, 1.33 feet at 2 p. m. December 7, 1913 (discharge, 4.7 million gallons per day, or 7.3 second-feet); ditch occasionally dry.

DIVERSIONS.—None above station.

REGULATION.—Water may be turned out of ditch by gates.

UTILIZATION.—Irrigation of sugar cane and taro.

ACCURACY.—Gage read twice daily. Discharge determined from well-defined rating curve and reliable gage heights. Records good for all stages.

Discharge measurements of Palolo ditch near Waikapu, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 24	0.98	4.0	2.6	Mar. 24	.64	1.75	1.1
Oct. 14	1.04	4.15	2.7	May 26	.90	3.46	2.2
Jan. 20	.76	2.44	1.6				

Daily discharge, in million gallons, of Palolo ditch near Waikapu, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	3.3	2.7	2.7	3.3	3.0	2.7	1.6	2.2	2.0	2.0	1.8	2.2
2	3.3	2.7	3.0	3.3	3.0	3.0	1.6	2.0	2.0	2.0	2.0	2.2
3	3.3	2.7	2.0	3.3	3.0	3.3	1.6	1.8	2.0	2.0	2.0	2.2
4	3.3	2.7	1.2	3.3	3.0	3.3	1.8	1.8	2.0	2.0	1.8	2.2
5	3.3	2.7	1.2	3.0	3.3	2.7	1.8	1.8	2.0	2.2	2.2	2.2
6	3.3	2.7	1.2	3.0	3.3	2.7	1.6	2.0	2.0	2.2	2.2	2.2
7	3.3	2.7	1.3	3.0	3.0	2.7	1.6	2.0	2.0	2.2	2.2	2.2
8	3.3	2.4	1.2	3.0	3.0	2.7	1.6	2.0	2.0	2.2	2.2	2.2
9	3.3	2.4	1.2	3.0	3.0	2.7	1.6	2.0	2.0	2.2	2.2	2.4
10	3.3	2.4	3.0	3.0	3.0	3.6	2.2	2.0	2.0	2.2	2.2	2.2
11	3.3	2.4	3.0	3.0	2.7	2.7	2.2	2.0	2.0	2.2	2.2	2.4
12	3.3	2.7	3.0	3.0	2.7	1.2	2.0	1.8	2.0	2.2	2.2	2.2
13	3.3	2.7	3.0	3.0	2.7	2.4	1.8	2.0	2.0	2.2	2.2	2.2
14	3.3	3.0	3.0	3.0	2.7	1.8	1.8	1.2	2.0	2.2	2.2	2.2
15	3.0	2.7	3.0	3.0	2.7	1.6	1.8	1.2	2.0	2.2	2.2	2.2
16	3.0	2.7	3.0	3.0	3.0	3.3	1.6	1.2	2.0	2.2	2.2	2.2
17	3.3	3.3	3.0	3.0	3.3	3.3	1.6	1.3	2.0	2.2	2.2	2.2
18	3.0	3.3	3.0	3.0	3.0	3.3	1.6	1.6	.....	2.2	2.2	2.0
19	3.0	3.3	3.0	3.0	2.7	3.0	1.6	1.2	.....	2.2	2.2	2.0
20	3.0	3.0	3.0	3.0	2.7	3.3	1.8	1.2	.3	2.2	2.2	2.0
21	3.0	3.0	2.7	3.0	2.7	3.3	1.8	1.2	1.2	2.2	2.2	2.0
22	2.7	3.0	2.7	3.0	2.7	3.3	2.2	1.2	2.0	2.2	2.2	2.2
23	2.7	3.0	2.7	3.0	2.7	3.3	2.2	1.2	2.0	2.2	2.2	2.2
24	2.7	3.0	2.7	3.0	2.7	3.6	2.2	1.2	2.0	2.2	2.4	2.2
25	2.7	3.0	2.7	3.0	2.7	3.3	2.2	1.2	2.0	2.2	2.4	2.0
26	2.7	3.0	2.7	3.3	2.4	3.8	2.2	1.2	2.0	2.2	2.2	2.0
27	3.0	3.0	2.7	3.3	2.4	3.6	2.2	2.0	2.0	2.2	2.2	2.2
28	2.7	2.7	2.7	3.3	3.0	3.6	2.2	2.0	2.0	2.2	2.2	2.2
29	2.7	2.7	2.7	3.0	3.0	3.3	2.2	.....	2.0	3.3	2.2	2.2
30	2.7	2.7	2.7	3.0	2.7	3.3	2.2	.....	2.0	1.6	2.2	2.2
31	3.0	2.7	.....	3.0	.....	3.3	2.2	.....	2.0	.....	2.2	.....

NOTE.—Discharge determined from well-defined rating curve. No flow Mar. 18 and 19; intake damaged by flood.

Digitized by Google

Monthly discharge of Palolo ditch near Waikapu, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	3.3	2.7	3.07	4.75	95	292
August	3.3	2.4	2.81	4.35	87	267
September	3.0	1.2	2.50	3.87	75	230
October	3.3	3.0	3.07	4.75	95	292
November	3.3	2.4	2.86	4.43	86	263
December	3.8	1.2	3.00	4.64	93	285
January	2.2	1.6	1.89	2.92	59	180
February	2.2	1.2	1.62	2.51	46	139
March (29 days)	2.0	.3	1.91	2.95	56	170
April	3.3	1.6	2.19	3.39	66	202
May	2.4	1.8	2.17	3.36	67	206
June	2.4	2.0	2.17	3.36	65	200
The year					890	2,730

SOUTH SIDE WAIKAPU DITCH NEAR WAIKAPU, MAUI.

LOCATION.—One mile below intake, 1½ miles west of Waikapu, and about 5½ miles by road southwest of Wailuku.

RECORDS AVAILABLE.—November 21, 1910, to June 30, 1917.

GAGE.—Vertical staff on right bank.

DISCHARGE MEASUREMENTS.—Made from plank over ditch at gage.

CHANNEL AND CONTROL.—Channel is cut in earth and soft rock; section fairly uniform; banks vertical. Control not well defined but fairly permanent between times of cleaning ditch.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 0.98 foot August 14 (discharge, 12 million gallons per day, or 19 second-feet); ditch dry April 14.

Maximum stage recorded during period of record, 1.25 feet at 9 a. m. May 8, 1914 (discharge, 16 million gallons per day, or 25 second-feet); ditch occasionally dry.

DIVERSIONS.—None above station.

REGULATION.—Practically none.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Gage read twice daily. Discharge determined from well-defined rating curve and reliable gage-height record. Records good for all stages.

Discharge measurements of South Side Waikapu ditch near Waikapu, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
July 24	H. A. R. Austin	0.51	7.2	4.7
Sept. 16	do	.43	5.8	3.8
Oct. 14	do	.36	5.27	3.4
Jan. 20	do	.39	5.46	3.5
Mar. 24	do	.09	1.46	.95
May 26	do	.46	4.58	3.0
June 27	C. T. Bailey	.40	6.26	4.0

Digitized by Google

Daily discharge, in million gallons, of South Side Waikapu ditch near Waikapu, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	6.2	7.7	4.8	4.2	3.6	3.0	4.2	3.0	2.5	3.0	3.6	3.0
2	5.5	8.4	7.7	4.8	3.6	5.5	3.6	3.0	2.5	3.0	2.5	3.6
3	6.2	9.2	6.2	3.6	3.6	8.4	3.6	2.5	3.0	3.0	4.8	3.0
4	2.5	7.0	4.8	3.6	3.6	7.0	3.6	2.5	4.2	3.0	4.2	3.0
5	7.0	6.2	4.2	3.6	7.7	4.8	3.6	2.5	3.6	3.6	4.2	3.0
6	6.2	5.5	4.2	3.6	5.5	4.2	3.6	2.5	3.6	3.0	3.6	3.0
7	5.5	5.5	7.0	3.6	4.2	3.6	3.6	2.5	3.0	3.0	3.6	3.0
8	4.8	5.5	4.8	3.6	3.6	4.2	3.0	2.5	3.0	2.5	3.6	6.2
9	4.8	5.5	4.2	3.0	3.6	3.6	3.0	2.5	3.0	2.5	3.6	6.2
10	5.5	5.5	4.2	3.6	3.0	9.2	3.0	2.5	3.0	3.0	3.6	4.2
11	6.2	4.8	4.2	3.0	3.0	6.2	5.5	2.5	4.8	3.6	3.6	7.7
12	5.5	7.0	4.2	3.0	3.0	5.5	4.2	2.5	3.6	3.6	3.6	3.6
12	4.8	7.7	4.2	3.6	3.0	5.5	3.6	2.5	3.0	3.0	3.6	3.0
14	5.5	12.0	3.6	3.0	2.5	6.2	3.6	6.2	3.0	.....	3.6	3.0
15	5.5	6.2	4.2	3.0	2.5	5.5	3.6	3.6	2.5	3.0	3.6	3.0
16	5.5	5.5	4.2	3.0	3.6	5.5	3.6	3.6	2.5	3.0	3.0	2.5
17	6.2	5.5	3.6	4.2	7.7	3.0	3.6	3.0	2.5	3.6	3.6	2.5
18	6.2	4.8	3.6	3.0	4.8	3.6	3.6	4.2	.....	3.0	4.2	2.5
19	6.2	4.8	5.5	3.0	3.6	4.8	4.2	5.5	.....	3.0	4.2	2.5
20	5.5	4.8	4.2	3.0	3.6	4.2	3.0	4.2	.....	4.8	4.2	2.5
21	5.5	4.8	4.2	3.0	3.0	7.0	3.0	3.6	.....	3.6	6.2	2.5
22	5.5	4.2	3.6	3.6	3.0	7.7	3.0	3.0	.....	3.0	4.2	7.0
23	5.5	4.2	5.5	4.8	3.0	7.0	2.5	3.0	.....	3.0	5.5	3.0
24	4.8	4.2	5.5	3.6	3.0	3.0	2.5	3.0	.....	3.0	5.5	3.0
25	4.8	4.2	4.8	3.0	2.5	4.8	2.5	3.0	.....	3.0	4.8	2.5
26	5.5	4.8	4.2	7.0	2.5	6.2	3.6	2.5	3.6	3.0	4.2	2.5
27	7.0	4.2	4.2	5.5	2.5	4.8	3.6	2.5	3.0	3.0	4.2	4.8
28	7.0	4.2	3.6	5.5	7.0	4.8	4.8	2.5	3.0	3.6	4.2	4.8
29	5.5	4.2	3.6	4.2	5.5	4.8	4.2	.....	3.0	8.4	3.6	3.6
30	4.8	4.2	4.2	3.6	3.6	4.2	5.5	.....	3.6	5.5	3.6	3.0
31	9.2	4.8	.....	3.6	.....	4.2	3.6	.....	3.6	.....	3.0	.....

NOTE.—Discharge determined from well-defined rating curve. Ditch dry on days for which discharge is not given.

Monthly discharge of South Side Waikapu ditch near Waikapu, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	9.2	2.5	5.69	8.80	176	541
August	12.0	4.2	5.71	8.83	177	543
September	7.7	3.6	4.57	7.07	137	421
October	7.0	3.0	3.75	5.80	116	357
November	7.7	2.5	3.83	5.93	115	353
December	9.2	3.0	5.23	8.09	162	498
January	5.5	2.5	3.62	5.60	112	344
February	6.2	2.5	3.10	4.80	87	266
March (23 days)	4.8	2.5	3.18	4.92	73	224
April (29 days)	8.4	2.5	3.42	5.29	99	304
May	6.2	2.5	3.98	6.16	124	379
June	7.7	2.5	3.59	5.55	108	331
The year	.....	.....	.....	.....	1,490	4,560

WEST KOPILIULA STREAM NEAR KEANAE, MAUI.

LOCATION.—600 feet above Koolau ditch crossing and highway bridge, 4½ miles by trail east of Upper Keanae, and 6 miles east of Keanae post office.

RECORDS AVAILABLE.—January 3, 1914, to June 30, 1917.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 300 feet below gage.

CHANNEL AND CONTROL.—Channel at gage is a large pool at foot of falls; banks rock and nearly vertical. Control at outlet of pool composed of large boulders; seldom shifts

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 9.25 feet at 5.30 a. m. January 18, 1916 (discharge, computed from extension of rating curve, approximately 2,000 million gallons per day, or 3,090 second-feet); minimum stage recorded, 0.55 foot March 21, 1914 (discharge, 1.8 million gallons per day, or 2.8 second-feet).

Maximum stage recorded during year, 7.0 feet at 5 a. m. March 9 (discharge, approximately 1,400 million gallons per day, or 2,166 second-feet); minimum stage recorded during year, 0.8 foot February 23–26 (discharge, 2.0 million gallons per day, or 3.1 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Normal flow is diverted into Koolau ditch for irrigation of sugar cane.

ACCURACY.—Records good for all stages except extreme floods.

Discharge measurements of West Kopiliula Stream near Keanae, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 15	H. A. R. Austin	1.59	26	17
Sept. 14	do	1.22	11	7.2
Dec. 10	do	4.72	780	504
Jan. 16	R. C. Rice	1.14	7.8	5.0
Mar. 20	H. A. R. Austin	1.41	17.7	11

Daily discharge, in million gallons, of West Kopiliula Stream near Keanae, Maui, for the year ending June 30, 1917.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	17	40	18	22	25	27	12	3.8	4.4	5.0	11	3.3
2	11	33	22	9.0	75	35	12	3.8	3.3	4.4	9.0	14
3	12	35	11	5.0	53	53	16	3.3	11	4.4	7.0	6.0
4	10	16	9.0	4.4	33	25	50	3.3	29	5.0	5.0	6.0
5	11	11	14	4.4	174	14	29	2.8	10	11	4.4	10
6	8.0	14	14	4.4	75	11	38	2.8	5.0	5.0	4.4	9.0
7	8.0	11	38	3.8	22	9.0	33	2.8	4.4	5.0	3.8	5.0
8	8.0	10	22	4.4	17	9.0	16	2.8	23	4.4	3.8	7.0
9	8.0	10	14	4.4	12	38	12	2.8	85	3.8	3.8	5.0
10	8.0	11	12	3.3	11	250	11	2.8	80	5.0	3.8	4.4
11	14	20	9.0	3.3	10	46	10	2.8	25	14	3.8	7.0
12	9.0	27	8.0	8.0	9.0	22	10	2.8	17	5.0	5.0	3.8
13	16	35	8.0	3.8	8.0	22	9.0	2.8	14	4.4	3.8	3.3
14	17	33	7.0	3.3	8.0	33	8.0	10	12	10	9.0	3.3
15	20	18	7.0	3.8	20	31	7.0	2.8	22	8.0	9.0	3.3
16	31	11	6.0	3.8	96	40	6.0	2.8	7.0	7.0	12.	2.8
17	43	12	6.0	8.0	85	102	5.0	2.4	5.0	8.0	43	2.8
18	18	14	7.0	5.0	17	116	4.4	2.4	31	6.0	80	3.3
19	14	22	23	5.0	11	80	4.4	2.8	29	5.0	17	2.8
20	10	25	9.0	5.0	8.0	57	4.4	2.8	12	7.0	10	2.8
21	8.0	25	8.0	3.8	8.0	210	4.4	3.3	7.0	6.0	10	2.4
22	8.0	20	17	3.8	7.0	400	3.8	2.4	5.0	4.4	9.0	4.4
23	7.0	17	17	3.8	7.0	490	3.8	2.0	5.0	5.0	10	2.8
24	5.0	17	12	3.8	10	40	3.8	2.0	5.0	3.8	8.0	2.8
25	5.0	11	8.0	4.4	7.0	22	6.0	2.0	12	3.8	5.0	2.4
26	7.0	9.0	10	27	14	17	70	2.0	12	3.8	4.4	2.4
27	10	10	9.0	29	23	20	9.0	3.8	5.0	3.8	4.4	4.4
28	10	11	7.0	16	31	29	6.0	23	5.0	16	4.4	5.0
29	9.0	8.0	6.0	17	25	18	5.0	.....	9.0	210	3.8	3.3
30	16	7.0	7.0	23	57	16	5.0	.....	10	40	3.3	2.8
31	80	16	.....	17	.....	12	3.8	.....	8.0	.....	3.3	.....

NOTE.—Discharge determined from well-defined rating curve. Discharge July 13–14, 22–28, Aug. 2–5, 29–31, Sept. 9–12, Dec. 22–23, 25–26, Jan. 25–26, and Mar. 16 determined by comparison with records of East Wailuaiki stream.

Digitized by Google

Monthly discharge of West Kopiliula Stream near Keanae, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	80	5.0	14.8	22.9	458	1,410
August	40	7.0	18.0	27.8	559	1,710
September	38	6.0	12.2	18.9	365	1,120
October	29	3.3	8.47	13.1	263	806
November	174	7.0	31.9	49.4	958	2,940
December	490	9.0	74.0	114	2,294	7,040
January	70	3.8	13.5	20.9	418	1,280
February	23	2.0	3.78	5.85	106	325
March	85	3.3	16.5	25.5	512	1,570
April	210	3.8	14.1	21.8	424	1,300
May	80	3.3	10.1	15.6	314	961
June	14	2.4	4.59	7.10	138	423
The year	490	2.0	18.7	28.9	6,810	20,900

EAST WAILUAIKI STREAM NEAR KEANAE, MAUI.

LOCATION.—1,000 feet above Koolau ditch crossing and trail, 3¾ miles east of Upper Keanae, and about 6¼ miles east of Keanae post office.

RECORDS AVAILABLE.—December 21, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder, installed April 17, 1914, to replace original Friez recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 800 feet below gage.

CHANNEL AND CONTROL.—Channel at gage is a large pool at foot of falls; banks are nearly vertical walls of rock. Control composed of large boulders and rock ledge; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 8.35 feet at 8 a. m. January 18, 1916 (discharge, computed from extension of rating curve, approximately 1,900 million gallons per day, or 2,940 second-feet); minimum stage recorded, 0.60 foot March 5–8, 1914, and August 14 and 15, 1195 (discharge, 2.5 million gallons per day or 3.9 second-feet).

Maximum stage recorded during year, 6.2 feet at 7 a. m. December 23 (discharge, approximately 1,300 million gallons per day, or 2,010 second-feet); minimum stage recorded, 0.75 foot, February 18 and 24–27 (discharge, 3.3 million gallons per day, or 5.1 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Normal flow is diverted into Koolau ditch for irrigation of sugar cane.

ACCURACY.—Determinations based on continuous record of gage height and rating curves well defined for low and medium stages; good for all except flood stages, for which they are fair.

40532°—18—WSP 465——10

Digitized by Google

Discharge measurements of East Wailuaiki Stream near Keanae, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Sept. 14	1.06	15	9.8	Mar. 20	1.12	14.9	9.6
Dec. 10	4.45	957	618	Apr. 18	1.05	12.7	8.2

Daily discharge, in million gallons, of East Wailuaiki Stream near Keanae, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	19	44	20	18	20	30	14	6.0	8.2	5.0	14	4.4
2	17	48	27	12	48	40	14	5.0	4.4	4.4	9.4	15
3	17	52	14	8.2	48	62	15	5.0	5.0	4.4	9.4	7.0
4	14	22	12	8.2	27	30	56	5.0	30	6.0	7.0	7.0
5	15	18	18	7.2	155	16	30	5.0	12	8.2	6.0	9.4
6	12	14	18	7.2	88	12	33	4.4	7.0	5.0	5.0	12
7	12	12	44	7.2	22	11	33	4.4	5.0	4.4	5.0	7.0
8	11	12	24	7.2	18	9.6	17	3.8	14	4.4	5.0	8.2
9	9.4	11	20	7.2	14	44	14	3.8	86	4.4	5.0	7.0
10	11	12	18	6.1	12	296	12	4.4	36	3.8	5.0	6.0
11	15	20	14	6.1	11	48	12	3.8	15	14	5.0	11
12	14	30	12	20	11	22	11	3.8	15	6.0	7.0	6.0
13	19	36	11	8.2	9.6	20	9.4	3.8	14	5.0	5.0	5.0
14	22	36	9.6	7.2	8.2	33	9.4	9.4	12	8.2	9.4	5.0
15	17	22	9.6	7.2	16	33	8.2	4.4	22	8.2	11	4.4
16	24	16	9.6	7.2	95	36	7.0	3.8	12	7.0	11	4.4
17	51	16	9.6	12	95	102	7.0	3.8	6.0	8.2	40	3.8
18	22	16	9.6	9.6	18	102	7.0	3.3	30	8.2	93	5.0
19	17	22	33	8.2	12	81	6.0	3.8	30	7.0	15	4.4
20	14	27	16	8.2	11	52	6.0	4.4	12	8.2	11	3.8
21	11	24	11	7.2	9.6	210	6.0	5.0	7.0	7.0	9.4	3.8
22	11	22	18	7.2	9.6	366	6.0	4.4	5.0	6.0	11	7.0
23	9.4	22	22	8.2	8.2	418	6.0	3.8	5.0	6.0	12	4.4
24	8.2	18	22	7.2	11	73	6.0	3.3	5.0	5.0	11	4.4
25	8.2	12	18	7.2	9.6	27	9.4	3.3	11	5.0	8.2	3.8
26	9.4	12	11	36	18	22	86	3.3	12	5.0	6.0	3.8
27	14	12	11	48	24	22	12	3.3	6.0	4.4	6.0	8.2
28	14	11	9.6	14	33	30	8.2	36	5.0	15	5.0	9.4
29	11	11	8.2	11	22	19	7.0	.....	9.4	250	5.0	6.0
30	19	11	8.2	27	48	15	7.0	.....	9.4	47	5.0	5.0
31	93	22	.....	22	.....	14	6.0	.....	7.0	.....	4.4	.....

NOTE.—Discharge determined from rating curves applicable as follows: July 1–31 and Dec. 23, 1916, to June 30, 1917, well defined below 20 million gallons per day; Aug. 1 to Dec. 23, 1916, well defined. Discharge Mar. 12–20 determined by comparison with records of flow of West Kopiliula Stream.

Digitized by Google

Monthly discharge of East Wailuaiki Stream near Keanae, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	93	8.2	18.1	28.0	561	1,720
August	52	11	21.4	33.1	663	2,040
September	44	8.2	16.3	25.2	488	1,500
October	48	6.1	12.2	18.9	377	1,160
November	155	8.2	31.1	48.1	932	2,860
December	418	9.6	74.1	115	2,300	7,050
January	86	6.0	15.5	24.0	481	1,470
February	36	3.3	5.48	8.48	154	471
March	86	4.4	14.8	21.8	457	1,410
April	250	3.8	16.0	24.8	480	1,470
May	93	4.4	11.7	18.1	361	1,110
June	15	3.8	6.39	9.89	192	588
The year	418	3.3	20.4	31.6	7,450	22,800

WEST WAILUAIKI STREAM NEAR KEANAE, MAUI.

LOCATION.—500 feet above Koolau ditch crossing and trail bridge, 3 miles east of Upper Keanae, and 5½ miles east of Keanae post office.

RECORDS AVAILABLE.—January 1, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 100 feet below gage.

CHANNEL AND CONTROL.—Channel at gage is a large deep pool at foot of low waterfall; banks are nearly vertical walls of rock to above high water. Control at outlet of pool composed of rock ledge and large boulders; probably permanent.

EXTREMES OF DISCHARGE.—Flood of January 18, 1916, carried away gage shelter and must have reached a stage of about 13 feet (discharge, possibly 4,000 million gallons per day, or 6,190 second-feet); minimum stage recorded, 0.8 foot March 7–12, 1914 (discharge, 1.6 million gallons per day, or 2.5 second-feet).

Maximum stage recorded during year, 7.9 feet at 3 a. m. March 9 (discharge, approximately 1,500 million gallons per day, or 2,320 second-feet); minimum stage recorded, 0.9 foot February 11–13, 17 and 18, 24–26 (discharge, 2.5 million gallons per day, or 3.7 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Normal flow is diverted into Koolau ditch for irrigation of sugar cane.

ACCURACY.—Determinations based on well-defined rating curves and continuous gage-height record. Records good for all stages.

Discharge measurements of West Wailuaiki Stream near Keanae, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons per day.
Aug. 15	H. A. R. Austin	1.81	32	21
Oct. 19	do	1.31	11	7.1
Dec. 10	do	6.30	1,040	673
Jan. 17	R. C. Rice	1.15	9.3	6.0

Digitized by Google

Daily discharge, in million gallons, of West Wailuaiki Stream near Keanae, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	21	55	21	16	23	36	12	4.2	8.5	5.8	18	4.2
2	15	44	29	11	68	46	11	3.5	5.0	5.0	11	21
3	16	46	14	7.5	62	72	15	3.5	21	5.0	9.8	9.8
4	12	20	12	6.5	36	34	65	3.5	34	8.5	6.5	11
5	15	15	20	5.8	228	18	31	3.0	15	11	5.8	18
6	9.8	18	18	5.0	84	14	44	3.0	7.5	6.5	5.0	15
7	9.8	15	62	5.0	25	11	36	3.0	5.0	7.5	4.2	8.5
8	9.8	12	29	5.8	18	11	18	3.0	21	5.8	4.2	9.8
9	9.8	12	25	5.8	12	52	14	3.0	84	5.0	4.2	7.5
10	9.8	15	21	5.0	11	392	11	3.0	36	8.5	3.5	6.5
11	18	25	16	5.0	9.8	62	9.8	2.5	16	34	3.5	12
12	11	36	12	9.8	8.5	25	8.5	2.5	9.8	6.5	6.5	6.5
13	20	46	9.8	5.8	6.5	21	7.5	2.5	7.5	7.5	4.2	5.0
14	21	44	8.5	5.0	6.5	41	6.5	11	5.8	7.5	14	5.0
15	25	21	7.5	5.8	27	38	5.8	3.5	11	7.5	12	4.2
16	41	14	6.5	5.8	123	55	5.8	3.0	6.5	6.5	15	3.5
17	58	14	5.8	9.8	80	123	5.8	2.5	6.5	7.5	58	3.5
18	23	15	6.5	7.5	18	112	5.0	2.5	36	7.5	97	5.0
19	18	27	41	7.5	11	97	4.2	3.0	27	5.8	18	3.5
20	12	34	16	5.8	8.5	68	4.2	4.2	14	8.5	11	3.5
21	8.5	27	11	5.0	7.5	344	4.2	8.5	7.5	6.5	12	3.0
22	7.5	23	18	5.0	6.5	545	4.2	3.5	5.8	5.8	12	6.5
23	6.5	23	25	6.5	5.8	728	3.5	3.0	6.5	5.8	14	3.5
24	5.8	20	27	5.0	8.5	58	3.5	2.5	5.8	5.0	12	3.0
25	5.8	12	20	5.0	7.5	36	7.5	2.5	11	4.2	9.8	3.0
26	7.5	11	11	49	18	25	92	2.5	12	4.2	6.5	3.0
27	12	9.8	9.8	44	27	23	14	3.5	5.8	4.2	6.5	8.5
28	14	9.8	8.5	14	38	34	8.5	52	5.8	25	6.5	8.5
29	11	9.8	7.5	14	34	20	5.8	.....	12	310	5.8	5.0
30	29	7.5	7.5	25	76	15	5.8	.....	12	62	5.0	3.5
31	129	21	.....	23	.....	12	4.2	.....	8.5	.....	4.2	.....

NOTE.—Discharge determined from well defined rating curves applicable as follows: July 1 to Dec. 23, 1916, and Dec. 24, 1916, to June 30, 1917. Discharge July 6–20, Aug. 1–14, Oct. 11–18, Nov. 29 to Dec. 10, Dec. 23 and 24, and Apr. 14–17 determined by comparison with records of flow of West Kopiliula Stream.

Monthly discharge of West Wailuaiki Stream near Keanae, Maui, for year ending June 30 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	129	5.8	19.7	30.5	612	1,870
August	55	7.5	22.6	35.0	702	2,150
September	62	5.8	17.5	27.1	526	1,610
October	49	5.0	10.9	16.9	337	1,040
November	228	5.8	36.5	56.5	1,090	3,360
December	728	11	102	158	3,170	9,700
January	92	3.5	15.3	23.7	473	1,460
February	52	2.5	5.28	8.17	148	454
March	84	5.0	15.2	23.5	470	1,450
April	310	4.2	20.0	30.9	600	1,840
May	97	3.5	13.1	20.3	406	1,250
June	21	3.0	7.02	10.9	210	646
The year	728	2.5	24.0	37.1	8,750	26,800

EAST WAILUANUI STREAM NEAR KEANAE, MAUI.

LOCATION.—1,000 feet above Koolau ditch crossing, 2½ miles east of Upper Keanae and 5 miles east of Keanae post office.

RECORDS AVAILABLE.—January 1, 1914, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

Digitized by Google

CHANNEL AND CONTROL.—Channel at gage a small deep pool at foot of rapids; right bank vertical wall of rock; left bank steep and high. Control at outlet is ledge of rock; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 5.1 feet at 5.45 a. m. December 23, 1916 (discharge, computed from extension of rating curve, approximately 430 million gallons per day or 665 second-feet); minimum stage recorded, 0.75 foot April 7, 1915 (discharge, 0.25 million gallons per day, or 0.4 second-foot).

Minimum stage recorded during year, 0.9 foot February 12–19 and May 6–11 (discharge, 0.7 million gallons per day, or 1.1 second feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Normal flow is diverted into Koolau ditch for irrigation of sugar cane.

ACCURACY.—Determinations based on a well-defined rating curve and a continuous record of gage height. Records good for all stages.

Discharge measurements of East Wailuanui Stream near Keanae, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height.	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Sept. 14	1.15	3.0	1.95	Jan. 17	1.03	2.4	1.6
Dec. 10	1.95	56	36				

Daily discharge, in million gallons, of East Wailuanui Stream near Keanae, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	5.2	12	8.0	4.4	3.7	7.0	3.0	1.6	2.0	2.0	3.0	1.6
2	4.4	17	10	2.5	10	12	3.0	1.3	1.6	1.6	2.0	5.2
3	4.4	15	5.2	1.6	9.0	36	3.7	1.3	2.0	1.3	1.6	2.0
4	3.7	7.0	3.7	1.3	5.2	10	12	1.3	4.4	1.6	1.0	2.0
5	3.7	7.0	6.0	1.3	27	4.4	7.0	1.3	2.0	4.4	1.0	3.0
6	3.0	5.2	7.0	1.3	15	3.0	6.0	1.0	1.6	2.0	.7	4.4
7	2.5	4.4	12	1.3	6.0	3.7	7.0	1.0	1.6	1.6	.7	2.5
8	2.5	3.7	8.0	1.0	4.4	3.0	3.7	1.0	3.7	1.3	.7	3.7
9	2.0	3.7	6.0	1.3	3.0	19	3.0	1.0	15	1.3	.7	3.0
10	2.5	3.7	6.0	1.3	3.0	53	2.5	1.0	4.4	1.3	.7	2.0
11	6.0	7.0	4.4	1.3	2.5	12	2.5	1.0	3.0	6.0	.7	6.0
12	3.0	9.0	3.7	2.5	2.0	10	2.0	.7	3.0	2.0	1.6	2.5
13	9.0	14	2.5	1.3	1.6	9.0	2.0	.7	2.0	1.6	1.0	2.0
14	3.7	21	2.5	1.3	1.6	12	1.6	.7	1.6	2.5	2.0	1.6
15	5.2	7.0	2.5	1.3	3.7	9.0	1.6	.7	4.4	3.0	1.6	1.3
16	19	5.2	2.5	1.6	10	9.0	1.6	.7	2.5	2.5	2.5	1.3
17	12	5.2	2.0	3.7	14	17	1.3	.7	1.6	3.0	9.0	1.3
18	7.0	7.0	2.0	3.0	3.7	25	1.6	.7	2.5	3.0	23	1.6
19	5.2	8.0	9.0	2.0	3.0	23	1.6	.7	2.0	2.5	4.4	1.3
20	3.7	9.0	3.0	2.0	2.0	12	1.6	1.0	1.6	3.0	3.0	1.3
21	3.0	9.0	2.5	1.6	2.0	29	1.6	1.0	1.6	2.0	3.7	1.0
22	3.0	10	4.4	1.6	1.6	38	1.3	1.0	1.3	2.0	4.4	3.0
23	2.5	7.0	6.0	2.5	1.6	60	1.3	1.0	1.3	2.0	5.2	1.6
24	2.5	5.2	4.4	1.6	3.0	19	1.3	1.0	1.3	1.6	3.7	1.3
25	2.0	3.7	3.7	1.6	2.0	7.0	3.0	1.0	3.0	1.3	3.0	1.3
26	3.0	3.7	1.6	12	4.4	5.2	23	1.0	6.0	1.3	2.0	1.3
27	6.0	3.7	1.3	14	8.0	6.0	3.7	1.0	2.0	1.3	2.0	3.0
28	6.0	3.7	1.0	4.4	10	8.0	2.5	17	2.0	3.0	2.0	3.7
29	4.4	3.0	1.0	4.4	6.0	5.2	2.0	.....	3.0	56	1.6	2.0
30	7.0	3.0	1.0	8.0	12	4.4	1.6	.....	3.0	10	1.6	1.6
31	27	8.0	.....	5.2	.....	3.7	1.6	.....	2.5	.....	1.6	.....

NOTE.—Discharge determined from a well-defined rating curve.

Digitized by Google

Monthly discharge of East Wailuanui Stream near Keanae, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	27	2.0	5.62	8.70	174	535
August	21	3.0	7.45	11.5	231	709
September	12	1.0	4.43	6.85	133	408
October	14	1.0	3.04	4.70	94	289
November	27	1.6	6.03	9.33	181	555
December	60	3.0	15.3	23.7	475	1,460
January	23	1.3	3.59	5.55	111	342
February	17	.7	1.55	2.40	43	133
March	15	1.3	2.89	4.47	90	275
April	56	1.3	4.27	6.61	128	393
May	23	.7	2.96	4.58	92	282
June	6.0	1.0	2.31	3.57	69	213
The year	60	.7	4.99	7.72	1,820	5,590

WEST WAILUANUI STREAM NEAR KEANAE, MAUI.

LOCATION.—Fifty feet above Koolau ditch crossing and intake, 2 miles east of Upper Keanae and 4½ miles east of Keanae post office.

RECORDS AVAILABLE.—December 19, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above gage; waterfall 50 feet below gage; banks steep and high. Control low concrete dam 30 feet long.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 7.03 feet at 6.30 a. m., January 18, 1916 (discharge, computed from extension of rating curve, approximately 760 million gallons per day, or 1,180 second-feet); minimum discharge recorded, 0.7 million gallons per day, or 1.1 second-feet, February, 1914, July and August, 1915, October, 1916, April and May, 1917.

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Irrigation of sugar cane, rice, and taro.

ACCURACY.—Record July 1 to April 29 based on a well-defined rating curve and a continuous gage-height record; good for all stages; record April 30 to May 22, fair.

Discharge measurements of West Wailuanui Stream near Keanae, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 21	1.13	6.8	4.4	Feb. 14	1.36	24	15
Sept. 14	1.12	5.85	3.8	Mar. 21	1.06	3.8	2.4
Jan. 17	1.08	2.75	1.8	May 21	1.00	13.3	8.6

Digitized by Google

Daily discharge, in million gallons, of West Wailuanui Stream near Keanae, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	9.3	12	12	7.0	4.8	15	4.8	3.2	4.8	3.2	12
2	7.0	25	15	4.8	25	21	4.8	3.2	3.2	3.2	4.8
3	7.0	15	7.0	3.2	21	39	15	3.2	4.8	3.2	3.2
4	4.8	7.0	3.2	3.2	12	12	18	3.2	9.3	7.0	1.8
5	4.8	7.0	3.2	1.8	120	7.0	9.3	3.2	4.8	3.2	1.8
6	3.2	4.8	1.8	1.8	45	4.8	15	3.2	3.2	3.2	1.8
7	3.2	4.8	1.8	1.8	12	4.8	9.3	3.2	3.2	3.2	1.8
8	3.2	4.8	1.8	1.8	7.0	4.8	7.0	3.2	7.0	3.2	1.8
9	3.2	4.8	1.8	1.8	4.8	21	4.8	3.2	25	3.2	1.8
10	3.2	4.8	1.8	1.8	4.8	140	4.8	3.2	9.3	4.8	1.8
11	4.8	9.3	1.8	1.8	3.2	18	4.8	3.2	7.0	7.0	.7
12	3.2	12	4.8	4.8	3.2	12	3.2	3.2	7.0	1.8	1.8
13	9.3	15	7.0	3.2	3.2	9.3	3.2	3.2	4.8	1.8	.7
14	4.8	21	3.2	1.8	3.2	25	3.2	7.0	3.2	3.2	3.2
15	4.8	9.3	3.2	1.8	12	12	1.8	3.2	9.3	3.2	3.2
16	18	7.0	3.2	1.8	45	39	3.2	3.2	4.8	3.2	3.2
17	18	9.3	3.2	4.8	45	69	3.2	1.8	3.2	3.2	21
18	9.3	9.3	3.2	3.2	9.3	45	3.2	1.8	4.8	1.8	57
19	7.0	12	12	3.2	4.8	34	3.2	1.8	4.8	1.8	9.3
20	4.8	12	4.8	1.8	3.2	69	3.2	3.2	3.2	3.2	4.8
21	4.8	12	3.2	1.8	3.2	186	3.2	3.2	1.8	1.8	4.8
22	3.2	15	7.0	.7	1.8	276	3.2	3.2	1.8	1.8	4.8
23	3.2	9.3	9.3	.7	3.2	140	3.2	3.2	1.8	1.8	.....
24	3.2	7.0	7.0	1.8	3.2	25	3.2	3.2	3.2	1.8	.....
25	1.8	3.2	7.0	1.8	7.0	15	4.8	3.2	7.0	.7	.....
26	1.8	3.2	4.8	12	12	9.3	45	3.2	3.2	.7	.....
27	4.8	3.2	3.2	12	15	18	7.0	3.2	1.8	.7	.....
28	3.2	3.2	3.2	3.2	9.3	9.3	7.0	29	3.2	4.8	.....
29	1.8	3.2	3.2	3.2	18	7.0	4.8	.....	3.2	120	.....
30	18	3.2	3.2	4.8	18	7.0	4.8	.....	3.2	51	.....
31	21	12	.....	4.8	.....	4.8	3.2	.....	3.2	.....	.....

NOTE.—Discharge determined from rating curves, applicable as follows: July 1 to Apr. 29, well defined; Apr. 30 to May 22, fairly well defined. Discharge Aug. 19 to Sept. 13, and Feb. 14 to Mar. 19 determined by comparison with records of flow of East Wailuanui Stream. Control washed out Apr. 29. No record May 23 to June 30.

Monthly discharge of West Wailuanui Stream near Keanae, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	21	1.8	6.44	9.96	200	613
August	25	3.2	9.05	14.0	281	861
September	15	1.8	4.90	7.58	147	451
October	12	.7	3.35	5.18	104	319
November	120	1.8	16.0	24.8	479	1,470
December	276	4.8	41.9	64.8	1,300	3,990
January	45	1.8	6.92	10.7	214	658
February	29	1.8	4.11	6.36	115	353
March	25	1.8	5.16	7.98	160	491
April	120	.7	8.42	13.0	253	775
May 1-22	57	.7	6.69	10.4	147	452
The period	.....	.....	.....	.....	3,400	10,400

HONOMANU STREAM NEAR KEANAE, MAUI.

LOCATION.—Five hundred feet above Spreckels ditch intake and trail bridge, about 6 miles south of Keanae post office.

RECORDS AVAILABLE.—November 15, 1913, to June 30, 1917.

GAGE.—Stevens water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 200 feet above and below gage; stream bed filled with large boulders and very rough; right bank vertical wall of rock; left bank steep and high. Control composed of large boulders; fairly permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 9.9 feet at 9 p. m., May 1, 1916 (discharge, computed from extension of rating curve, approximately 1,200 million gallons per day, or 1,860 second-feet); minimum stage recorded, 2.20 feet April 7 and 8, 1915 (discharge, 0.25 million gallons per day, or 0.4 second-feet).

Maximum stage recorded during year, 8.85 feet at 5.30 a. m. December 23 (discharge, approximately 1,000 million gallons per day, or 1,550 second-feet); minimum stage recorded, 2.05 feet February 10–13 (discharge, 0.9 million gallons per day, or 1.4 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Natural flow is diverted by Spreckels ditch for irrigation of sugar cane.

ACCURACY.—Records below 10 million gallons per day based on a well-defined rating curve and a continuous gage-height record; good; records for higher stages fair.

Discharge measurements of Honomanu Stream near Keanae, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 20	2.65	10.4	6.7	Feb. 13	2.05	1.4	0.9
Sept. 13	2.60	9.35	6.0	Mar. 19	2.30	3.8	2.5
Oct. 20	2.38	4.38	2.8	May 20	2.50	6.3	4.1
Dec. 9	5.01	300	194				

Daily discharge, in million gallons, of Honomanu Stream near Keanae, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	11	35	11	8.7	8.7	13	3.3	1.4	4.3	6.4	25	2.5
2	8.7	38	21	9.7	30	30	2.9	1.1	2.5	5.7	9.7	30
3	11	41	8.7	7.1	35	41	3.8	1.1	15	2.5	9.7	7.9
4	7.9	13	7.1	5.7	14	21	44	1.1	25	7.1	5.0	8.7
5	9.7	9.7	12	5.7	134	7.9	18	1.1	8.7	9.7	3.3	18
6	7.9	8.7	11	5.0	73	6.4	25	1.1	3.8	4.3	3.8	9.7
7	7.1	7.1	41	5.0	13	5.7	18	1.1	2.9	4.3	3.3	8.7
8	6.4	6.4	13	5.0	8.7	5.7	7.1	1.1	2.9	3.3	2.5	11
9	5.7	6.4	11	4.3	5.7	23	5.0	1.1	5.0	2.9	2.5	7.1
10	7.1	6.4	8.7	4.3	5.0	262	4.3	.9	2.9	2.9	2.1	5.0
11	18	9.7	7.9	3.8	5.7	35	5.7	.9	2.5	8.7	2.5	8.7
12	9.7	21	7.1	5.0	4.3	11	6.4	.9	2.1	3.8	5.7	4.3
13	13	21	6.4	6.4	3.8	13	3.8	.9	3.3	2.9	4.3	3.8
14	14	25	5.7	5.0	3.3	21	3.3	8.7	2.9	4.3	12	2.5
15	15	13	9.7	5.7	5.7	15	2.9	2.5	5.0	4.3	6.4	2.5
16	23	7.9	5.0	5.7	95	20	2.5	1.7	2.9	3.8	11	2.5
17	30	7.9	3.8	9.7	107	68	2.5	1.4	2.1	5.7	35	1.7
18	11	7.9	4.3	7.1	13	35	2.5	1.1	2.5	3.8	38	3.3
19	7.9	15	32	5.7	5.7	44	2.5	2.9	2.5	2.9	6.4	2.5
20	7.1	16	7.9	3.3	4.3	28	2.1	5.7	2.1	5.0	4.3	1.7
21	6.4	13	5.7	2.9	3.8	195	2.1	7.9	2.1	3.8	6.4	1.7
22	5.0	8.7	8.7	2.5	3.3	345	2.1	2.1	1.7	4.3	7.1	7.1
23	5.0	11	12	3.8	2.9	395	1.7	1.7	1.7	3.3	12	2.9
24	4.3	8.7	13	4.3	5.7	55	1.7	1.4	2.1	2.9	11	2.1
25	4.3	6.4	9.7	3.3	5.7	14	2.5	1.4	2.1	2.5	7.9	1.7
26	4.3	6.4	7.1	23	13	7.9	21	1.4	5.0	2.5	3.8	1.7
27	7.9	6.4	7.9	16	15	9.7	3.8	2.1	2.5	2.1	3.3	8.7
28	7.9	6.4	6.4	5.7	25	16	2.1	35	2.5	9.7	5.0	7.1
29	7.1	7.1	5.0	4.3	18	7.9	2.1	.....	7.9	271	3.3	3.8
30	16	5.7	5.0	20	23	5.0	1.7	.....	5.7	89	2.9	2.5
31	95	13	.....	13	.....	3.8	1.7	.....	3.8	.....	2.5	.....

NOTE.—Discharge determined from a rating curve well defined below 10 million gallons per day; fairly well defined for higher stages.

Digitized by Google

Monthly discharge of Honomanu Stream near Keanae, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	95	4.3	12.7	19.6	394	1,210
August	41	5.7	13.2	20.4	409	1,260
September	41	3.8	10.5	16.2	315	967
October	23	2.5	6.99	10.8	217	665
November	134	2.9	23.0	35.6	690	2,120
December	395	3.8	56.8	87.9	1,760	5,400
January	44	1.7	6.71	10.4	208	638
February	35	.9	3.24	5.01	91	278
March	25	1.7	4.45	6.88	138	423
April	271	2.1	16.2	25.1	485	1,490
May	38	2.1	8.31	12.9	258	791
June	30	1.7	6.05	9.36	181	557
The year	395	.9	14.1	21.8	5,150	15,800

HAIPUAENA STREAM NEAR HUELO, MAUI.

LOCATION.—200 feet above inflow of Spreckels ditch, about 7 miles by trail east of Huelo.

RECORDS AVAILABLE.—October 19, 1913, to June 30, 1917; also records of combined flow of stream and Spreckels ditch at staff-gage station 600 feet below present site December 18, 1910, to September 30, 1913.

GAGE.—Stevens water-stage recorder installed June 16, 1914, to replace original Friez recorder.

DISCHARGE MEASUREMENTS.—Made by wading of from footbridge.

CHANNEL AND CONTROL.—One channel at all stages; straight for 200 feet above and below gage; right bank high with steep slope; left bank nearly vertical. Control composed of large boulders; fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.1 feet at 4.30 a. m. March 1, 1916 (discharge, computed from extension of rating curve, 350 million gallons per day, or 542 second-feet); minimum stage recorded, 0.2 foot March 8, 1914 (discharge 1.0 million gallons per day, or 1.5 second-feet).

Maximum stage recorded during year, 4.85 feet at 6 a. m. December 23 (discharge, approximately 320 million gallons per day, or 495 second-feet); minimum stage recorded, 0.35 foot February 13 (discharge, 1.6 million gallons per day, or 2.5 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Ordinary flow diverted by ditches of East Maui Irrigation Co. for irrigation of sugar cane.

ACCURACY.—Rating curve well defined. Records good for all stages.

Discharge measurements of Haipuaena Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.
Aug. 14	1.76	58	37
Sept. 13	.76	7.55	4.9

Digitized by Google

Daily discharge, in million gallons, of Haipuaena Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	11	30	12	9.5	9.5	15	5.2	2.5	5.9	5.2	15	3.4
2	7.6	30	26	9.5	24	28	5.2	2.5	4.0	5.2	6.8	18
3	8.6	35	8.6	5.2	28	40	5.9	2.5	8.6	3.4	5.2	5.9
4	6.8	13	7.6	4.5	13	20	28	2.5	18	5.9	4.5	5.9
5	7.6	9.5	12	4.5	66	9.5	13	2.2	7.6	9.5	3.4	8.6
6	5.9	7.6	9.5	4.0	43	7.6	16	2.2	5.2	4.5	3.0	8.6
7	5.2	6.8	18	4.0	13	6.8	15	2.2	4.5	4.5	3.0	5.9
8	4.5	5.9	16	4.0	11	6.8	7.6	1.8	5.2	4.0	2.5	9.5
9	4.5	5.2	11	4.0	7.6	24	5.9	1.8	7.6	4.0	2.5	7.6
10	5.2	5.2	11	3.4	6.8	93	5.2	1.8	5.2	3.4	2.5	5.9
11	15	11	7.6	3.4	6.8	22	5.2	1.8	4.5	9.5	3.0	11
12	7.6	18	6.8	4.0	5.9	11	5.9	1.8	4.0	4.5	4.5	5.9
13	11	22	5.9	4.0	5.2	12	4.0	1.6	4.0	4.0	4.0	4.5
14	12	28	5.2	3.0	4.5	18	4.0	5.9	4.0	4.5	5.9	4.5
15	12	13	7.6	3.4	7.6	15	3.4	2.5	6.8	5.2	5.2	4.0
16	20	8.6	5.9	3.4	49	18	3.4	2.2	5.2	4.5	5.2	3.4
17	32	8.6	4.5	8.6	52	40	3.0	2.2	4.0	5.9	22	3.4
18	13	9.5	5.2	6.8	11	30	3.0	1.8	3.4	4.5	28	4.5
19	11	16	30	5.2	6.8	35	3.0	3.0	3.0	4.0	6.8	3.4
20	6.8	18	9.5	4.0	5.2	24	3.0	4.5	3.0	5.2	5.9	3.0
21	5.9	15	6.8	3.4	4.5	81	2.5	5.9	2.5	4.5	6.8	3.0
22	5.2	11	11	3.4	4.5	118	2.5	3.0	2.5	5.2	6.8	6.8
23	5.2	9.5	13	5.2	4.0	132	2.5	2.2	2.5	4.0	12	4.0
24	4.5	8.6	15	4.5	6.8	35	2.5	2.2	3.0	3.0	8.6	3.4
25	4.0	5.9	12	3.4	5.9	13	4.0	2.2	3.4	3.0	6.8	3.0
26	4.5	5.9	6.8	24	12	9.5	18	2.2	5.2	3.0	4.5	3.0
27	9.5	5.9	6.8	18	15	11	4.5	2.2	3.4	2.5	4.5	8.6
28	8.6	5.9	5.9	7.6	24	15	3.4	32	3.4	5.9	4.5	7.6
29	6.8	5.9	5.2	7.6	18	8.6	3.4	.....	6.8	101	4.0	5.2
30	13	5.2	4.5	22	22	6.8	3.0	.....	5.9	38	3.4	4.0
31	56	12	.....	13	.....	5.9	3.0	.....	5.2	.....	3.4	.....

NOTE.—Discharge determined from a well-defined rating curve.

Monthly discharge of Haipuaena Stream near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	56	4.0	10.7	16.6	330	1,020
August	35	5.2	12.6	19.5	392	1,200
September	30	4.5	10.2	15.8	307	939
October	24	3.0	6.79	10.5	210	646
November	66	4.0	16.4	25.4	493	1,510
December	132	5.9	29.4	45.5	912	2,800
January	28	2.5	6.26	9.69	194	596
February	32	1.6	3.61	5.58	101	310
March	18	2.5	5.08	7.86	158	483
April	101	2.5	9.05	14.0	272	833
May	28	2.5	6.59	10.2	204	627
June	18	3.0	5.85	9.05	176	539
The year	132	1.6	10.3	15.9	3,750	11,500

Digitized by Google

PUOHAKAMOA STREAM NEAR HUELO, MAUI.

LOCATION.—150 feet above Spreckels ditch inflow and trail crossing, about 7 miles east of Huelo.

RECORDS AVAILABLE.—June 13, 1913, to June 30, 1917 (new station); December 18, 1910, to June 18, 1913 (old station).

GAGE.—Barrett & Lawrence water-stage recorder installed June 13, 1913. Old staff gage station was 150 feet downstream at trail bridge below inflow from Spreckels ditch.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 200 feet below gage. Inflow of Spreckels ditch must be deducted from measurements made at footbridge.

CHANNEL AND CONTROL.—One channel at all stages; curves 100 feet above and below gage; banks steep and high; stream bed very rough and steep. Control composed of large boulders; seldom shifts.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 7.55 feet at 10 a. m. May 1, 1916 (discharge, computed from extension of rating curve, approximately 800 million gallons per day, or 1,240 second-feet); minimum stage recorded, 0.9 foot February 23–26, 1917 (discharge, 1.8 million gallons per day, or 2.8 second-feet).

Maximum stage recorded during year, 7.2 feet at 11 a. m. December 23 (discharge, approximately 750 million gallons per day, or 1,160 second-feet).

DIVERSIONS.—Kula pipe line diverts small amount of water above station at elevation 4,300 feet.

REGULATION.—None.

UTILIZATION.—Ordinary flow of stream is diverted by East Maui Irrigation Co.'s ditches for irrigation of sugar cane.

ACCURACY.—Determinations based on a fairly well defined rating curve and continuous gage-height record. Records fair for all stages.

Discharge measurements of Puohakamoa Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
July 20	2.08	22	14	Mar. 22	1.01	4.1	2.7
Oct. 18	1.87	19.9	13	Apr. 17	1.94	22.3	14
Dec. 11	2.74	53	34	May 20	1.80	16.6	11
Feb. 13	.92	3.0	1.9				

Digitized by Google

Daily discharge, in million gallons, of Puohakamoa Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	26	71	24	19	20	24	14	4.0	8.5	7.2	.....	4.5
2	20	77	44	19	44	59	14	4.0	4.5	7.2	.....	26
3	20	84	17	11	53	98	17	4.0	13	4.0	.....	13
4	18	30	14	9.1	33	40	77	4.0	20	9.7	.....	12
5	20	22	23	7.8	180	19	36	3.6	11	16	.....	18
6	15	18	22	7.2	65	15	48	3.6	6.0	7.8	.....	16
7	14	16	77	6.6	26	14	40	3.1	4.0	6.6	.....	12
8	13	14	30	6.6	20	14	22	3.1	6.6	5.0	.....	19
9	11	14	23	6.6	16	40	15	3.1	9.1	4.5	.....	14
10	14	14	23	6.0	14	244	14	2.8	5.0	5.0	.....	11
11	33	26	17	6.0	14	48	14	2.8	4.0	18	.....	20
12	18	44	14	6.0	11	24	16	2.4	4.0	7.2	.....	11
13	30	59	5.0	5.5	9.7	28	11	1.8	4.0	5.0	.....	9.1
14	20	71	10	5.5	8.5	33	9.1	8.5	3.6	6.6	.....	7.2
15	26	30	14	5.0	19	36	7.8	3.6	10	8.5	.....	6.6
16	65	18	13	5.0	142	30	7.8	2.4	5.5	7.2	.....	5.5
17	65	18	9.1	5.0	84	84	7.2	2.1	4.0	11	.....	5.0
18	28	20	11	9.7	18	77	6.6	1.8	4.5	7.8	.....	9.1
19	22	36	65	9.1	14	77	6.0	4.5	4.0	5.5	15	6.0
20	16	36	18	6.0	13	53	6.0	6.0	3.1	9.7	12	5.0
21	14	30	14	5.0	10	165	5.5	8.5	2.8	7.2	16	4.0
22	12	22	18	5.0	9.1	244	5.0	2.8	2.4	7.2	15	14
23	10	18	26	8.5	8.5	329	5.0	1.8	3.1	6.0	20	8.5
24	9.7	18	26	7.8	16	105	5.0	1.8	3.1	4.5	18	5.0
25	9.1	14	20	5.0	12	33	8.5	1.8	4.5	3.6	14	4.5
26	9.7	14	13	20	23	23	28	1.8	8.5	3.6	9.7	4.0
27	18	13	16	48	36	19	11	2.1	3.6	2.8	8.5	16
28	18	13	11	15	44	30	7.2	44	4.0	7.8	9.7	14
29	15	13	9.1	9.7	33	20	6.0	.....	11	65	7.2	10
30	22	9.7	8.5	53	44	16	5.5	.....	11	30	6.0	6.0
31	135	16	.....	22	.....	14	5.0	.....	9.7	.....	5.0	.....

NOTE.—Discharge determined from fairly well defined rating curve. No record May 1–18.

Monthly discharge of Puohakamoa Stream near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	135	9.1	24.7	38.2	766	2,350
August	84	9.7	29.0	44.9	899	2,760
September	77	5.0	21.2	32.8	635	1,950
October	53	5.0	11.6	17.9	361	1,100
November	180	8.5	34.7	53.7	1,040	3,190
December	329	14	66.3	103	2,060	6,310
January	77	5.0	15.5	24.0	480	1,470
February	44	1.8	4.85	7.50	136	417
March	20	2.4	6.39	9.89	198	608
April	65	2.8	9.91	15.3	297	912
May 19–31	20	5.0	12.0	18.6	156	479
June	26	4.0	10.5	16.2	316	967

ALO STREAM NEAR HUELO, MAUI.

LOCATION.—300 feet above Spreckels ditch inflow and trail crossing, about 5 miles east of Huelo.

RECORDS AVAILABLE.—December 18, 1910, to June 30, 1917.

GAGE.—Friez water-stage recorder installed June 18, 1914. Prior to June 18, 1914, vertical staff at trail bridge 300 feet downstream from present site.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—Channel at gage is a fairly large pool at foot of rapids; bank steep and high. Control at outlet of pool composed of rock ledge and large boulders; probably permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.35 feet at 7 p. m. December 9, 1916 (discharge, computed from extension of rating curve, approximately 550 million gallons per day, or 850 second-feet); minimum stage recorded, 1.34 feet (old datum) November 4, 1911 (discharge, 0.06 million gallons per day, or 0.1 second-foot).

Minimum stage recorded during year, 0.45 foot February 7–13, 15–18, and 22–26 (discharge, 0.8 million gallons per day, or 1.2 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Ordinary flow upstream diverted by ditches of East Maui Irrigation Co. for irrigation of sugar cane.

ACCURACY.—Determinations based on well-defined rating curve and continuous gage-height record. Records good for all stages except extreme floods.

Discharge measurements of Alo Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.
Dec. 11	0.93	8.3	5.4
Mar. 22	.54	1.57	1.0

Daily discharge, in million gallons, of Alo Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	5.4	11	6.2	7.0	4.7	6.2	3.3	1.3	1.6	2.1	5.4	1.3
2	4.0	14	7.0	4.7	7.0	12	2.6	1.0	1.3	1.6	3.3	4.0
3	3.3	14	2.6	2.6	8.2	47	4.0	1.0	2.1	1.6	2.6	1.6
4	2.6	6.2	2.1	2.1	6.2	9.3	9.3	1.0	3.3	2.1	2.1	1.6
5	4.0	5.4	2.1	2.1	34	5.4	7.0	1.0	2.1	2.6	2.1	1.6
6	2.6	4.0	4.0	1.6	16	4.0	6.2	1.0	1.3	1.6	2.1	3.3
7	2.1	4.0	9.3	1.6	7.0	3.3	5.4	.8	1.3	1.6	1.6	1.6
8	2.1	2.6	6.2	1.6	5.4	2.6	3.3	.8	3.3	1.6	1.6	6.2
9	1.6	2.6	4.0	1.6	4.0	16	2.6	.8	4.7	1.3	1.3	5.4
10	2.1	2.6	5.4	1.3	3.3	34	2.6	.8	1.6	1.3	1.3	2.6
11	6.2	6.2	3.3	1.3	3.3	7.0	2.1	.8	1.6	6.2	1.6	6.2
12	2.6	8.2	3.3	1.6	2.6	4.7	2.1	.8	2.6	2.1	2.1	2.6
13	6.2	16	2.6	1.3	2.1	6.2	1.6	.8	1.6	1.6	1.6	2.1
14	3.3	30	2.1	1.3	2.1	8.2	1.6	1.3	1.6	2.6	2.1	1.6
15	5.4	8.2	2.6	1.0	4.7	4.7	1.6	.8	5.4	3.3	1.3	1.6
16	12	4.7	2.1	1.6	9.3	8.2	1.3	.8	2.1	2.6	2.1	1.3
17	12	5.4	1.6	6.2	12	14	1.0	.8	1.6	4.0	6.2	1.3
18	6.2	5.4	2.1	3.3	4.7	18	1.3	.8	2.1	2.6	16	2.1
19	5.4	7.0	11	2.1	3.3	16	1.3	1.6	1.6	2.1	4.0	1.3
20	4.0	8.2	3.3	2.1	2.6	9.3	1.0	1.6	1.3	2.6	2.6	1.3
21	3.3	7.0	2.6	1.6	2.1	18	1.0	1.3	1.3	2.1	4.7	1.0
22	2.6	5.4	6.2	2.1	2.1	38	1.0	.8	1.3	2.1	3.3	2.6
23	2.1	4.0	7.0	4.7	1.6	42	1.0	.8	1.3	2.1	7.0	1.3
24	2.1	3.3	7.0	2.1	4.7	9.3	1.0	.8	1.3	1.6	4.7	1.0
25	1.6	2.6	5.4	2.1	2.1	4.7	4.0	.8	4.0	1.6	3.3	1.0
26	2.1	3.3	3.3	12	4.7	3.3	9.3	.8	2.6	1.6	2.6	1.0
27	5.4	2.6	3.3	11	8.2	4.7	2.1	1.6	1.6	1.6	2.1	2.6
28	4.7	2.6	2.6	4.0	12	4.7	1.6	9.3	1.6	5.4	2.1	2.6
29	3.3	2.1	2.1	5.4	8.2	3.3	1.3	.....	2.6	74	1.6	2.6
30	4.7	1.6	2.1	11	11	2.6	1.3	.....	2.6	11	1.6	1.3
31	16	6.2	.....	5.4	.....	3.3	1.3	.....	4.7	.....	1.3	.....

NOTE.—Discharge determined from rating curve well defined below 50 million gallons per day.

Digitized by Google

Monthly discharge of Alo Stream near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	16	1.6	4.55	7.04	141	433
August	30	1.6	6.66	10.3	206	634
September	11	1.6	4.15	6.42	124	382
October	12	1.0	3.53	5.46	109	336
November	34	1.6	6.64	10.3	199	611
December	47	2.6	11.9	18.4	370	1,130
January	9.3	1.0	2.78	4.30	86	264
February	9.3	.8	1.28	1.98	36	110
March	5.4	1.3	2.23	3.45	69	212
April	74	1.3	5.01	7.75	150	461
May	16	1.3	3.14	4.86	97	299
June	6.2	1.0	2.25	3.48	68	207
The year	74	.8	4.54	7.02	1,660	5,080

WAIKAMOI STREAM NEAR HUELO, MAUI.

LOCATION.—500 feet above Spreckels ditch intake and 5 miles by trail east of Huelo post office.

RECORDS AVAILABLE.—December 18, 1910, to June 30, 1917.

GAGE.—Friez water-stage recorder installed October 14, 1913, at new datum, to replace original staff.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below gage; banks high and covered with vegetation. Water drops over a fall at control, which is rock ledge and boulders and fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 7.57 feet at 5 a. m. January 18, 1916 (discharge, computed from extension of rating curve, approximately 1,800 million gallons per day, or 2,780 second-feet); minimum stage recorded, 1.08 feet September 28, 1912 (discharge, 0.3 million gallons per day, or 0.5 second-foot).

Maximum stage recorded during year, 4.95 feet at 4 a. m. December 23 (discharge, approximately 830 million gallons per day, or 1,280 second-feet); minimum stage recorded, 0.05 foot February 11–13 and 26 (discharge, 0.8 million gallons per day, or 1.2 second-feet).

DIVERSIONS.—A small amount of water is diverted by Kula pipe line above station at elevation 4,300 feet.

REGULATION.—None.

UTILIZATION.—Low water is all diverted by ditches of East Maui Irrigation Co. for irrigation of sugar cane.

ACCURACY.—Records based on a fairly well defined rating curve and continuous gage-height record; fair below 100 million gallons per day.

Discharge measurements of Waikamoi Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Aug. 14	1.72	114	73	Mar. 19	.42	4.21	2.7
Sept. 13	.68	15	9.7	Mar. 22	.29	3.05	2.0
Oct. 20	.39	5.77	3.7	May 20	.76	16.6	11

Digitized by Google

Daily discharge, in million gallons, of Waikamoi Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	20	58	25	14	16	28	7.4	1.6	7.4	6.4	45	5.4
2	16	62	38	16	42	58	6.4	1.4	3.0	7.4	20	28
3	16	62	16	7.4	45	49	7.4	1.4	12	4.0	18	10
4	13	25	12	5.4	22	25	45	1.6	28	6.4	13	10
5	14	18	20	4.7	126	12	34	1.4	13	12	8.7	16
6	10	14	22	4.0	72	8.7	42	1.4	6.4	5.4	8.7	14
7	6.4	12	62	3.5	20	7.4	28	1.2	4.0	4.7	7.4	10
8	5.4	8.7	28	3.5	16	7.4	13	1.2	4.7	4.0	6.4	16
9	4.7	8.7	22	3.5	12	25	8.7	1.0	6.4	3.5	5.4	13
10	6.4	10	20	3.0	10	148	7.4	1.0	4.0	3.0	5.4	8.7
11	28	22	16	2.6	10	34	10	.8	2.6	13	5.4	13
12	14	45	12	4.0	6.4	18	16	.8	3.5	4.7	7.4	8.7
13	22	42	10	2.6	4.7	28	7.4	.8	4.7	3.5	8.7	6.4
14	20	53	7.4	2.2	4.7	38	5.4	12	4.7	4.0	14	5.4
15	28	22	10	3.0	4.7	18	4.0	4.7	7.4	4.7	13	4.7
16	38	13	12	3.5	88	38	3.5	1.9	5.4	4.0	12	4.7
17	53	18	6.4	14	53	72	3.0	1.4	2.6	6.4	42	4.7
18	22	20	6.4	10	16	49	2.6	1.2	2.6	5.4	45	4.7
19	16	31	53	7.4	10	53	2.2	3.5	2.6	3.5	13	4.7
20	10	34	18	4.0	8.7	45	1.9	5.4	2.6	5.4	12	4.7
21	7.4	25	12	2.6	6.4	180	1.9	7.4	1.9	4.0	12	4.0
22	6.4	18	16	2.6	5.4	240	1.6	3.0	1.9	5.4	10	6.4
23	5.4	16	25	4.7	4.0	347	1.6	1.4	2.2	4.7	16	5.4
24	4.7	16	25	4.7	7.4	67	1.6	1.0	2.2	3.5	16	4.7
25	4.0	12	22	3.0	10	25	3.5	1.0	2.6	3.0	12	4.0
26	5.4	12	13	7.4	18	16	25	.8	4.0	3.0	8.7	3.5
27	14	10	10	25	22	14	6.4	1.2	3.0	2.6	7.4	12
28	14	10	8.7	14	58	28	3.5	42	3.0	6.4	10	10
29	10	10	6.4	13	38	16	2.6	.....	6.4	172	7.4	7.4
30	28	6.4	5.4	34	53	10	2.2	.....	6.4	77	6.4	4.7
31	93	20	.....	22	.....	8.7	1.9	.....	4.7	.....	5.4	.....

NOTE.—Discharge determined from a rating curve fairly well defined below 100 million gallons per day. Discharge Nov. 28 to Dec. 2 and Dec. 12-16 determined by comparison with records of flow of Alo Stream.

Monthly discharge of Waikamoi Stream near Huelo, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	93	4.0	17.9	27.7	555	1,700
August	62	6.4	23.7	36.7	734	2,250
September	62	5.4	18.7	28.9	560	1,720
October	34	2.2	8.11	12.5	251	772
November	126	4.0	27.0	41.8	809	2,490
December	347	7.4	55.3	85.6	1,710	5,260
January	45	1.6	9.91	15.3	307	943
February	42	.8	3.70	5.72	104	318
March	28	1.9	5.35	8.28	166	509
April	172	2.6	13.1	20.3	393	1,210
May	45	5.4	13.6	21.0	422	1,290
June	28	3.5	8.50	13.2	255	783
The year	347	.8	17.2	26.6	6,270	19,200

NAILIILIHAELE STREAM NEAR HUELO, MAUI.

LOCATION.—300 feet above New Hamakua ditch, about 3 miles south of Huelo.

RECORDS AVAILABLE.—October 8, 1913, to June 30, 1917. Also at old staff-gage station below New Hamakua ditch from December 9, 1910, to December 31, 1912.

GAGE.—Barrett & Lawrence water-stage recorder installed October 8, 1913.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge 150 feet below gage.

CHANNEL AND CONTROL.—One channel at all stages; straight for 100 feet above and below gage; stream bed very rough and steep; banks steep and high and covered with dense vegetation. Control composed of large boulders; fairly permanent.

Digitized by Google

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 6.3 feet at 6.30 p. m. May 1, 1916 (discharge, computed from extension of rating curve, approximately 1,800 million gallons per day, or 2,780 second-feet); minimum stage recorded, 0.73 foot October 29 to November 1, 1913 (discharge, 2.3 million gallons per day, or 3.6 second-feet).

Maximum stage recorded during year, 3.95 feet at 8 p. m. December 9 (discharge, approximately 450 million gallons per day, or 696 second-feet); minimum stage recorded, 0.3 foot February 21 (discharge, 3.0 million gallons per day, or 4.6 second-feet).

DIVERSION.—None above station.

REGULATION.—None.

UTILIZATION.—Ordinary flow diverted by ditches of East Maui Irrigation Co. for irrigation of sugar cane.

ACCURACY.—Determinations based on well-defined rating curve and a continuous gage-height record. Records fair for all stages.

Discharge measurements of Nailiilihaele Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons. per day.
July 19	1.01	45	29	Dec. 11	1.12	50	32
Aug. 14	2.15	223	.144	Jan. 19	.52	10.1	6.5
Sept. 12	.86	28	18	Feb. 15	.37	6.3	4.1
Oct. 17	1.12	54.5	35	Mar. 22	.48	9.3	6.0

Daily discharge, in million gallons, of Nailiilihaele Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	32	72	45	20	32	38	12	5.6	7.8	12	45	9.0
2	26	35	78	35	58	62	12	5.6	5.6	10	29	49
3	26	84	38	20	78	137	16	5.6	10	10	20	18
4	20	109	35	16	45	49	53	5.6	16	16	20	16
5	20	62	38	16	183	29	35	5.6	9.0	29	16	14
6	18	45	38	16	109	23	32	5.6	6.6	16	20	26
7	16	38	62	12	53	20	38	5.6	4.6	10	14	16
8	14	42	62	12	45	16	20	4.6	12	9.0	12	32
9	12	62	38	12	38	72	16	3.8	26	9.0	12	29
10	12	58	45	10	35	167	16	4.6	9.0	9.0	9.0	20
11	32	32	23	7.8	32	45	14	4.6	6.6	32	9.0	38
12	18	84	18	6.6	32	29	14	4.6	5.6	16	9.0	20
13	32	53	18	6.6	26	35	10	4.6	5.6	12	9.0	12
14	26	78	16	6.6	26	38	7.8	4.6	5.6	10	9.0	10
15	26	42	23	6.6	42	32	6.6	4.6	16	16	9.0	9.0
16	38	29	16	6.6	84	32	6.6	4.6	9.0	14	9.0	9.0
17	84	23	14	20	84	72	6.6	4.6	6.6	14	32	7.8
18	42	29	12	16	26	72	6.6	4.6	6.6	16	84	7.8
19	26	45	45	12	18	78	6.6	3.8	5.6	12	23	7.8
20	23	29	20	10	16	49	5.6	3.8	4.6	16	18	7.8
21	20	29	20	9.0	14	123	5.6	3.0	4.6	16	20	7.8
22	20	29	14	9.0	14	160	5.6	3.8	5.6	16	23	20
23	14	20	32	12	10	231	5.6	3.8	6.6	16	32	16
24	10	18	29	10	14	116	5.6	3.8	6.6	14	26	10
25	12	26	26	7.8	16	42	14	4.6	6.6	7.8	20	9.0
26	12	26	20	38	29	32	38	3.8	4.6	7.8	20	7.8
27	14	18	16	53	38	26	9.0	3.8	4.6	7.8	16	20
28	20	18	14	18	67	45	6.6	49	4.6	84	16	26
29	16	18	14	14	32	26	6.6	.....	4.6	175	14	23
30	18	14	12	72	53	23	5.6	.....	7.8	96	12	12
31	144	14	.....	26	.....	18	5.6	.....	16	.....	12	.....

NOTE.—Discharge determined from well-defined rating curve. Discharge July 23–31, Aug. 12–19, 22–24 27–31, and Apr. 25–30 determined by comparison with record of flow of Kailua Stream.

Digitized by Google

Monthly discharge of Nailiilihaele Stream near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	144	10	27.2	42.1	843	2,590
August	109	14	41.3	63.9	1,280	3,930
September	78	12	29.4	45.5	881	2,710
October	72	6.6	17.3	26.8	537	1,650
November	183	10	45.0	69.6	1,350	4,140
December	231	16	62.5	96.7	1,940	5,950
January	53	5.6	14.3	22.1	442	1,360
February	49	3.0	6.15	9.52	172	528
March	26	4.6	8.08	12.5	251	769
April	175	7.8	24.3	37.6	728	2,240
May	84	9.0	20.0	30.9	619	1,900
June	49	7.8	17.0	26.3	510	1,560
The year	231	3.0	26.2	40.5	9,550	29,300

KAILUA STREAM NEAR HUELO, MAUI.

LOCATION.—About 800 feet above New Hamakua ditch crossing, 1 mile south of Huelo.

RECORDS AVAILABLE.—June 17, 1913, to June 30, 1917.

GAGE.—Barrett & Lawrence water-stage recorder installed October 1, 1913, at same location and datum as original staff gage.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—Channel at gage is a large, deep pool with high, sloping banks, at foot of low waterfall. Control at outlet of pool is solid rock ledge and large boulders; will seldom shift.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 9.5 feet May 1, 1916 (discharge, computed from extension of the rating curve, approximately 1,000 million gallons per day, or 1,550 second-feet); minimum stage recorded, 1 foot March 5 and 6, 1914 (discharge, 0.6 million gallons per day, or 0.9 second-feet.

Maximum stage recorded during year, 6.1 feet at 5.30 a. m. April 20 (discharge, approximately 450 million gallons per day, or 696 second-feet); minimum stage recorded, 1.2 feet December and February (discharge, 1.1 million gallons per day, or 1.7 second-feet).

DIVERSIONS.—A small amount of water is diverted by Old Hamakua ditch above station.

REGULATION.—None.

UTILIZATION.—Ordinary flow of stream is diverted by ditches of East Maui Irrigation Co for irrigation of sugar cane.

ACCURACY.—Rating curve is well defined below 20 million gallons per day, but. determinations are only fair for all stages because of lack of sensitiveness of water-stage recorder.

Discharge measurements of Kailua Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons. per day.
Sept. 12	1.67	13.8	8.9	Mar 23	1.32	3.54	2.3
Dec. 12	1.91	26.7	17				

Digitized by Google

Daily discharge, in million gallons, of Kailua Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	20	55	18	12	13	16	5.3	2.9	6.4	8.7	42	3.6
2	14	55	34	22	37	48	5.3	2.2	5.3	13	24	37
3	14	66	13	12	52	66	7.4	2.2	5.3	6.4	20	10
4	12	24	8.7	8.7	26	37	42	2.2	8.7	16	12	7.4
5	12	16	14	8.7	150	18	26	2.2	4.4	16	7.4	7.4
6	10	13	14	8.7	90	13	26	2.2	2.9	10	7.4	10
7	8.7	24	62	6.4	26	13	34	2.2	1.6	8.7	5.3	6.4
8	7.4	26	26	6.4	20	10	13	2.2	6.4	7.4	4.4	7.4
9	6.4	42	14	6.4	14	34	10	2.2	14	7.4	3.6	7.4
10	6.4	37	16	5.3	13	216	7.4	2.2	4.4	6.4	3.6	5.3
11	20	20	13	3.6	10	162	7.4	1.6	2.9	18	3.6	12
12	10	62	8.7	2.9	10	20	12	1.6	2.2	10	3.6	5.3
13	20	37	7.4	2.9	7.4	16	7.4	1.1	2.2	7.4	3.6	4.4
14	14	55	7.4	2.9	7.4	20	7.4	3.6	2.2	7.4	3.6	4.4
15	14	26	8.7	2.9	30	20	5.3	3.6	8.7	6.4	5.3	3.6
16	24	16	8.7	2.9	150	20	5.3	2.2	4.4	6.4	4.4	3.6
17	62	13	5.3	12	66	52	5.3	2.2	2.9	6.4	24	3.6
18	16	16	5.3	12	20	52	4.4	1.6	2.9	5.3	45	4.4
19	13	30	48	12	12	55	3.6	1.1	2.2	4.4	8.7	3.6
20	12	32	13	12	7.4	32	3.6	1.1	1.6	7.4	8.7	2.9
21	10	22	8.7	12	6.4	94	3.6	1.1	1.6	5.3	8.7	2.2
22	8.7	18	8.7	12	5.3	130	3.6	1.1	2.2	5.3	8.7	10
23	7.4	12	16	12	5.3	223	3.6	1.1	2.2	5.3	10	6.4
24	5.3	10	13	12	12	86	3.6	1.1	2.2	5.3	10	3.6
25	6.4	10	14	13	13	5.3	10	1.1	2.2	3.6	7.4	3.6
26	6.4	10	10	14	26	1.6	24	1.1	3.6	3.6	6.4	2.9
27	7.4	10	7.4	14	37	1.1	6.4	1.1	2.9	3.6	5.3	7.4
28	12	10	7.4	13	48	2.2	4.4	32	2.2	62	6.4	8.7
29	8.7	10	6.4	13	20	4.4	5.3	.....	5.3	145	5.3	6.4
30	10	7.4	7.4	13	34	5.3	5.3	.....	6.4	70	5.3	4.4
31	116	7.4	.....	13	.....	3.6	4.4	.....	6.4	.....	4.4	.....

NOTE.—Discharge determined from rating curve well defined below 20 million gallons per day and fairly well defined between 20 and 200 million gallons per day. Discharge July 1–17, Aug. 7–13, Oct. 1–17, Nov. 28–30, Dec. 15–24, Jan. 16–26, Feb. 19–23, 27 and 28, and Mar. 3–22 determined by comparison with records of flow of Nallililihaele Stream.

Monthly discharge of Kailua Stream near Huelo, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	116	5.3	16.6	25.7	514	1,580
August	66	7.4	25.5	39.5	792	2,430
September	62	5.3	14.8	22.9	444	1,360
October	22	2.9	9.80	15.2	304	932
November	150	5.3	32.3	50.0	968	2,970
December	223	1.1	47.6	73.6	1,480	4,530
January	42	3.6	10.1	15.6	312	961
February	32	1.1	2.93	4.53	82	252
March	14	1.6	4.15	6.42	129	395
April	145	3.6	16.3	25.2	488	1,500
May	45	3.6	10.3	15.9	318	980
June	37	2.2	6.84	10.6	205	630
The year	223	1.1	16.5	25.5	6,030	18,500

HOOLAWALIILII STREAM NEAR HUELO, MAUI.

LOCATION.—400 feet above New Hamakua ditch crossing, about 4 miles by trail west of Huelo.

RECORDS AVAILABLE.—April 5, 1911, to June 30, 1917.

GAGE.—Stevens water-stage recorder installed June 19, 1914, at same location and datum as original staff gage.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

Digitized by Google

CHANNEL AND CONTROL.—Channel at gage is a pool about 100 feet long and 10 feet wide formed by concrete control 12 feet long over which water makes a drop of about 50 feet; banks slope gently and are covered with dense growth of vegetation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 2.9 feet at 5 p. m., January 8, 1916 (discharge, computed from extension of rating curve, approximately 520 million gallons per day, or 805 second-feet); minimum stage recorded, 0.07 foot June 2 and 3, 1913 (discharge, 0.85 million gallons per day, or 1.3 second-feet).

Maximum stage recorded during year, 1.8 feet at 8 p. m., December 9 (discharge, approximately 250 million gallons per day, or 387 second-feet); minimum stage recorded, 0.05 foot August, September, February, and March (discharge, 1.3 million gallons per day, or 2.0 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

ACCURACY.—Record good below and fair above 20 million gallons per day.

Discharge measurements of Hoolawaliilii Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date.	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Sept. 12	0.15	5.95	3.9	Feb. 15	0.06	2.22	1.4
Oct. 17	.11	4.40	2.8	May 22	.16	5.48	3.5
Dec. 12	.24	8.15	5.3				

Daily discharge, in million gallons, of Hoolawaliilii Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	12	9.0	2.2	4.8	6.5	6.5	2.2	3.2	1.3	3.2	23	2.2
2	9.0	12	3.2	3.2	6.5	9.0	2.2	2.2	1.3	3.2	12	3.2
3	9.0	15	2.2	3.2	9.0	40	2.2	2.2	1.3	3.2	9.0	2.2
4	6.5	9.0	2.2	3.2	6.5	19	4.8	2.2	1.3	3.2	6.5	2.2
5	6.5	6.5	1.3	3.2	40	9.0	4.8	2.2	1.3	3.2	4.8	2.2
6	6.5	6.5	2.2	3.2	23	6.5	2.2	2.2	1.3	3.2	4.8	3.2
7	4.8	6.5	3.2	3.2	12	4.8	4.8	2.2	1.3	3.2	4.8	2.2
8	4.8	4.8	3.2	3.2	9.0	4.8	3.2	2.2	3.2	3.2	3.2	3.2
9	4.8	4.8	3.2	3.2	6.5	9.0	2.2	2.2	4.8	3.2	3.2	3.2
10	4.8	3.2	3.2	3.2	6.5	23	2.2	2.2	2.2	3.2	3.2	3.2
11	4.8	4.8	3.2	3.2	6.5	9.0	2.2	2.2	2.2	4.8	3.2	3.2
12	3.2	6.5	3.2	2.2	4.8	6.5	2.2	1.3	2.2	3.2	3.2	3.2
13	6.5	12	3.2	2.2	4.8	6.5	2.2	1.3	2.2	3.2	3.2	3.2
14	4.8	28	3.2	2.2	4.8	6.5	2.2	1.3	2.2	3.2	3.2	3.2
15	4.8	12	4.8	2.2	4.8	4.8	2.2	1.3	3.2	3.2	3.2	2.2
16	6.5	6.5	3.2	2.2	6.5	6.5	2.2	1.3	2.2	3.2	3.2	2.2
17	9.0	6.5	3.2	2.2	9.0	9.0	2.2	1.3	2.2	3.2	4.8	2.2
18	6.5	6.5	3.2	2.2	4.8	15	2.2	1.3	3.2	3.2	15	3.2
19	4.8	6.5	9.0	2.2	4.8	15	2.2	2.2	2.2	2.2	4.8	2.2
20	4.8	6.5	4.8	2.2	4.8	12	2.2	1.3	2.2	3.2	3.2	2.2
21	3.2	4.8	4.8	2.2	3.2	28	2.2	1.3	2.2	3.2	3.2	2.2
22	3.2	4.8	4.8	2.2	2.2	34	2.2	1.3	2.2	3.2	3.2	2.2
23	3.2	3.2	4.8	2.2	2.2	91	2.2	1.3	2.2	3.2	4.8	2.2
24	3.2	3.2	6.5	2.2	3.2	40	2.2	1.3	2.2	3.2	3.2	2.2
25	3.2	3.2	4.8	2.2	3.2	12	3.2	1.3	2.2	3.2	3.2	2.2
26	3.2	2.2	4.8	4.8	3.2	6.5	6.5	1.3	3.2	3.2	3.2	2.2
27	3.2	2.2	4.8	4.8	6.5	6.5	3.2	1.3	2.2	3.2	3.2	2.2
28	3.2	2.2	4.8	3.2	9.0	6.5	3.2	4.8	2.2	6.5	3.2	2.2
29	3.2	2.2	4.8	6.5	6.5	4.8	3.2	.....	2.2	66	3.2	3.2
30	3.2	1.3	4.8	12	6.5	3.2	3.2	.....	2.2	34	3.2	2.2
31	12	2.2	.....	6.5	.....	3.2	3.2	.....	3.2	.....	2.2	.....

NOTE.—Discharge determined from a rating curve well defined below 20 million gallons per day.

Digitized by Google

Monthly discharge of Hoolawaliilii Stream near Huelo, Maui, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	12	3.2	5.43	8.40	168	517
August	28	1.3	6.60	10.2	205	628
September	9.0	1.3	3.89	6.02	117	358
October	12	2.2	3.40	5.26	105	323
November	40	2.2	7.56	11.7	227	696
December	91	3.2	14.8	22.9	458	1,410
January	6.5	2.2	2.82	4.36	87	268
February	4.8	1.3	1.85	2.86	52	159
March	4.8	1.3	2.24	3.47	70	213
April	66	2.2	6.45	9.98	194	594
May	23	2.2	5.07	7.84	157	482
June	3.2	2.2	2.57	3.98	77	237
The year	91	1.3	5.25	8.12	1,920	5,880

HOOLAWANUI STREAM NEAR HUELO, MAUI.

LOCATION.—500 feet above crossing of New Hamakua ditch, about 5 miles by trail west of Huelo.

RECORDS AVAILABLE.—December 12, 1910, to June 30, 1917.

GAGE.—Stevens water-stage recorder installed June 20, 1914, 200 feet upstream from original staff which it replaced.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

CHANNEL AND CONTROL.—Stream drops over a low waterfall into a large circular pool with gently sloping banks. Control at outlet of pool composed of boulders; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 5.4 feet at 11.30 p. m. May 1, 1916 (discharge, computed from extension of rating curve, approximately 440 million gallons per day, or 680 second-feet); minimum stage recorded, 0.04 foot September and October, 1912 (discharge, 1.0 million gallons per day, or 1.6 second-feet).

Maximum stage recorded during year, 4.2 feet at 7 a. m. December 23 (discharge, approximately 300 million gallons per day, or 464 second-feet); minimum stage recorded, 0.05 foot October and February (discharge, 1.1 million gallons per day, or 1.7 second-feet).

DIVERSIONS.—None above station.

REGULATION.—None.

ACCURACY.—Determinations based on well-defined rating curve and continuous gage-height record. Records good for all stages below 60 million gallons per day.

Discharge measurements of Hoolawanui Stream near Huelo, Maui, during the year ending June 30, 1917.

Date.	Made by—	Gage height (feet).	Discharge.	
			Second-feet.	Million gallons. per day.
July 19	H. A. R. Austin	0.54	12	7.8
Jan. 19	R. C. Rice	.24	4.4	2.8

Digitized by Google

Daily discharge, in million gallons, of Hoolawanui Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	16	19	6.8	3.4	4.2	10	5.9	2.2	2.8	2.2	32	2.2
2	13	19	13	3.4	6.8	18	5.0	1.8	2.2	1.8	18	2.8
3	12	26	5.9	2.2	10	32	5.9	1.8	2.2	1.8	12	2.2
4	9.0	16	5.0	2.2	6.8	24	14	1.8	5.0	2.2	9.0	2.2
5	9.0	12	5.0	2.2	42	13	10	1.8	2.8	4.2	6.8	2.2
6	7.9	9.0	5.0	2.2	32	10	10	1.8	2.8	2.2	2.8	2.8
7	6.8	7.9	18	1.8	18	7.9	13	1.8	1.8	2.2	5.0	2.2
8	5.9	6.8	12	1.8	12	7.9	9.0	1.8	2.2	1.8	4.2	2.8
9	5.9	6.8	6.8	1.8	9.0	18	6.8	1.8	9.0	1.8	3.4	2.8
10	5.9	5.9	7.9	1.8	6.8	64	5.9	1.8	2.8	1.8	3.4	2.8
11	7.9	7.9	5.9	1.8	5.9	30	5.9	1.8	2.8	4.2	3.4	2.8
12	5.9	12	5.0	1.8	5.0	14	5.9	1.4	2.8	2.8	2.8	2.8
13	9.0	16	5.0	1.8	5.0	12	5.0	1.4	2.2	2.2	2.8	2.8
14	6.8	23	4.2	1.8	4.2	12	4.2	1.8	2.2	2.2	2.8	2.8
15	7.9	13	5.0	1.8	5.0	10	3.4	1.1	3.4	2.8	2.8	2.2
16	16	9.0	4.2	1.8	16	13	3.4	1.1	2.8	1.8	3.4	2.2
17	18	9.0	3.4	1.8	28	23	3.4	1.1	2.2	2.2	5.0	2.2
18	10	9.0	3.4	2.2	12	24	2.8	1.1	2.8	1.8	16	2.8
19	9.0	13	16	1.8	7.9	23	2.8	2.2	2.2	1.8	4.2	2.2
20	6.8	13	5.0	1.4	5.9	18	2.8	1.4	1.8	2.8	3.4	2.2
21	5.9	9.0	4.2	1.4	5.0	52	2.2	1.4	1.8	2.2	4.2	2.2
22	5.0	7.9	5.0	1.4	4.2	74	2.2	1.1	1.8	2.2	4.2	4.2
23	4.2	6.8	5.9	1.8	4.2	136	2.2	1.1	1.8	2.2	4.2	2.2
24	4.2	5.9	5.9	1.4	5.0	58	2.2	1.1	1.8	2.2	3.4	1.8
25	3.4	5.0	5.0	1.1	5.0	24	3.4	1.1	1.8	1.8	3.4	1.8
26	3.4	5.0	4.2	5.0	7.9	18	5.9	1.1	1.8	1.8	2.8	1.8
27	4.2	5.0	3.4	5.9	13	14	2.8	1.1	1.4	1.8	2.8	3.4
28	4.2	4.2	3.4	2.2	18	13	2.2	14	1.4	3.4	2.8	2.8
29	3.4	4.2	2.8	4.2	12	9.0	2.2	.....	2.2	52	2.2	3.4
30	5.0	3.4	2.8	14	14	7.9	2.8	.....	2.2	32	2.2	2.2
31	30	5.0	.....	5.9	.....	6.8	2.2	.....	3.4	.....	2.2	.....

NOTE.—Discharge determined from rating curve well defined below 60 million gallons per day. Discharge Oct. 12–17 and June 1–21 estimated by comparison with records of flow of Hoolawaliilii Stream.

Monthly discharge of Hoolawanui Stream near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	30	3.4	8.44	13.1	262	803
August	26	3.4	10.2	15.8	315	970
September	18	2.8	6.17	9.55	185	568
October	14	1.1	2.75	4.25	85	262
November	42	4.2	11.0	17.0	331	1,010
December	136	6.8	25.7	39.8	796	2,440
January	14	2.2	5.01	7.75	155	477
February	14	1.1	1.96	3.03	55	168
March	9	1.4	2.59	4.01	80	246
April	52	1.8	4.94	7.64	148	455
May	32	2.2	5.73	8.87	178	545
June	4.2	1.8	2.53	3.91	76	233
The year	136	1.1	7.30	11.3	2,670	8,180

HONOPOU STREAM NEAR HUELO, MAUI.

LOCATION.—200 feet above New Hamakua ditch crossing, about 6 miles west of Huelo.

RECORDS AVAILABLE.—December 10, 1910, to June 30, 1917.

GAGE.—Stevens water-stage recorder, installed June 19, 1914, at same location and datum as original staff.

DISCHARGE MEASUREMENTS.—Made by wading or from footbridge at gage.

Digitized by Google

CHANNEL AND CONTROL.—One channel at all stages; straight for 50 feet above and below gage; right bank is overflowed during floods; left bank steep and high. Control an old iron weir set in concrete; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 3.7 feet at 10 p. m., May 1, 1916 (discharge, computed from extension of rating curve, approximately 160 million gallons per day, or 248 second-feet); minimum stage recorded, 0.4 foot September and October, 1912 (discharge, 0.4 million gallons per day, or 0.6 second-foot).

Maximum stage recorded during year, 3.15 feet at 7 p. m., April 30 (discharge, approximately 120 million gallons per day, or 186 second-feet); minimum stage recorded, 0.1 foot October and February (discharge, 0.5 million gallons per day, or 0.77 second-foot).

DIVERSIONS.—None above station.

REGULATION.—None.

UTILIZATION.—Ordinary flow is diverted by ditches of East Maui Irrigation Co. for irrigation of sugar cane.

ACCURACY.—Discharge determined from rating curve well defined for low stages. Records for medium and flood stages fair.

Discharge measurements of Honopou Stream near Huelo, Maui, during the year ending June 30, 1917.

[Made by H. A. R. Austin.]

Date	Gage height (feet).	Discharge.		Date.	Gage height (feet).	Discharge.	
		Second-feet.	Million gallons per day.			Second-feet.	Million gallons per day.
Mar. 23	0.19	1.96	1.3	May 22	0.26	2.53	1.6
Apr. 19	.18	1.55	1.0				

Daily discharge, in million gallons, of Honopou Stream near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	5.5	4.6	1.8	1.8	1.8	3.0	2.4	1.3	1.3	1.3	17	1.8
2	4.6	6.5	2.4	1.8	2.4	5.5	1.8	.8	.8	1.3	9.5	2.4
3	3.8	6.5	1.3	1.3	3.0	17	2.4	.8	1.3	1.3	6.5	1.8
4	3.0	4.6	1.3	.8	2.4	9.5	3.0	.8	1.8	1.3	5.5	1.3
5	2.4	3.8	1.3	.8	22	6.5	2.4	.8	1.3	1.3	4.6	1.3
6	1.8	3.0	1.8	.8	12	4.6	3.0	.8	1.3	1.3	3.8	1.8
7	1.8	3.0	3.0	.8	6.5	3.8	3.0	.8	1.3	1.3	3.0	1.3
8	1.3	2.4	3.0	.8	5.5	3.8	3.0	.8	3.0	1.3	3.0	1.8
9	1.3	2.4	1.8	.5	3.8	6.5	3.0	.8	3.8	1.3	3.0	2.4
10	1.3	1.8	2.4	.5	3.8	13	3.0	.8	1.8	1.3	2.4	1.8
11	2.4	3.0	1.8	.5	3.8	8.5	3.0	.8	1.8	1.8	2.4	1.8
12	.8	3.8	1.3	.5	3.0	5.5	3.0	.8	1.8	1.3	2.4	1.3
13	2.4	6.5	1.3	.5	2.4	4.6	2.4	.8	1.8	1.3	1.8	1.3
14	1.3	11	1.3	.5	2.4	4.6	2.4	.8	1.8	1.3	1.8	1.3
15	1.3	4.6	2.4	.5	3.0	3.8	2.4	.8	3.0	1.3	1.8	1.3
16	3.0	3.8	1.3	.5	3.8	4.6	1.8	.5	1.8	1.3	2.4	1.3
17	3.8	3.8	1.3	.8	4.6	6.5	1.8	.5	1.3	1.3	4.6	1.3
18	2.4	3.0	1.3	.8	2.4	8.5	1.3	.8	2.4	1.3	6.5	1.3
19	2.4	4.6	6.5	.5	1.8	7.5	1.3	1.8	1.8	1.3	2.4	1.3
20	2.4	3.8	2.4	.5	1.8	6.5	1.3	.8	1.8	1.8	1.8	1.3
21	1.8	3.0	1.8	.5	1.8	15	1.3	.8	1.3	1.3	2.4	1.3
22	1.8	3.0	2.4	.5	1.3	22	1.3	.8	1.3	1.3	1.8	1.3
23	1.8	2.4	2.4	.8	1.3	38	1.3	.5	1.3	1.3	2.4	.8
24	1.3	2.4	3.0	.5	1.8	19	1.3	.5	1.3	1.3	2.4	.8
25	1.3	1.8	2.4	.5	1.3	12	2.4	.5	1.3	1.3	1.8	.8
26	1.3	1.8	2.4	2.4	1.8	8.5	3.8	.5	1.3	1.3	1.8	.8
27	1.8	1.8	2.4	1.8	3.8	6.5	1.3	.8	1.3	1.3	1.8	1.3
28	1.3	1.8	1.8	.8	6.5	5.5	1.3	5.5	1.3	3.0	1.8	1.3
29	1.3	1.3	1.8	3.0	3.8	3.8	1.3	.....	1.3	24	1.8	2.4
30	1.8	1.3	1.8	5.5	4.6	3.0	1.3	.....	1.3	19	1.8	.8
31	7.5	1.8	.....	1.8	.....	3.0	1.3	.....	1.3	.....	1.3	.....

NOTE.—Discharge determined from rating curve well defined below 5 million gallons per day. Discharge Dec. 25 to Jan. 1 and Mar. 30 to Apr. 19 determined by comparison with records of flow of Hoolawanui stream.

Digitized by Google

Monthly discharge of Honopou Stream near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	7.5	0.8	2.32	3.59	72	221
August	11	1.3	3.51	5.43	109	334
September	6.5	1.3	2.11	3.26	63	194
October	5.5	.5	1.08	1.67	34	103
November	22	1.3	4.01	6.20	120	369
December	38	3.0	8.71	13.5	270	829
January	3.8	1.3	2.12	3.28	66	202
February	5.5	.5	.96	1.49	27	82
March	3.8	.8	1.65	2.55	51	157
April	24	1.3	2.74	4.24	82	252
May	17	1.3	3.46	5.35	107	329
June	2.4	.8	1.43	2.21	43	132
The year	38	.5	2.86	4.43	1,040	3,200

NEW HAMAKUA DITCH AT HALEHAKU WEIR, NEAR HUELO, MAUI.

LOCATION.—Just above crossing of Halehaku Stream, about 7 miles by trail west of Huelo post office.

RECORDS AVAILABLE.—January 1, 1910, to June 30, 1917.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by 25-foot Cippoletti weir.

CHANNEL AND CONTROL.—Large pool at weir.

EXTREMES OF DISCHARGE.—See monthly-discharge table.

DIVERSIONS.—None above station.

REGULATION.—By gates at frequent intervals.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Records good.

COOPERATION.—Daily-discharge record copied from records of East Maui Irrigation Co.

Daily discharge, in million gallons, of New Hamakua ditch at Halehaku weir, near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	69.6	70.1	74.9	54.5	53.8	56.8	40.1	31.4	44.1	36.7	68.2	48.6
2	69.6	72.1	61.0	53.6	56.9	59.8	40.3	29.7	28.4	39.1	54.9	54.0
3	68.7	72.4	53.4	53.8	59.8	64.3	41.6	28.5	28.5	32.1	48.5	66.2
4	69.0	70.4	53.7	53.7	57.6	67.4	44.2	27.5	35.6	30.5	54.5	65.4
5	71.1	69.7	54.3	54.0	70.6	57.1	54.3	26.2	40.4	50.7	55.4	63.0
6	69.3	69.7	54.5	53.1	70.1	53.5	54.5	25.1	33.0	56.8	52.0	66.7
7	69.5	69.1	63.0	46.0	65.8	53.5	55.0	24.2	27.3	46.1	50.4	65.8
8	70.3	68.6	55.1	45.5	53.6	55.8	53.3	23.5	40.3	42.4	50.4	66.9
9	66.0	65.6	53.7	48.2	53.6	56.7	53.8	23.0	55.3	38.8	48.2	70.1
10	71.0	71.5	54.3	44.2	53.9	69.7	53.7	22.3	48.1	35.8	45.3	65.3
11	70.5	73.0	53.9	37.7	54.2	65.5	53.9	21.4	38.8	55.5	46.4	67.6
12	66.7	71.1	53.8	36.2	54.2	56.4	54.0	34.7	44.1	56.1	53.5	64.9
13	67.6	70.2	53.8	50.0	52.3	54.3	53.5	33.3	37.8	48.0	59.8	61.7
14	68.4	69.0	53.8	39.3	41.7	54.1	53.1	26.9	35.7	51.4	57.1	52.4
15	69.7	70.8	54.4	38.4	39.8	54.3	50.0	28.7	41.6	58.9	65.8	44.7
16	71.2	73.0	52.8	39.2	53.7	56.5	47.4	27.5	43.9	56.9	62.5	44.3
17	68.3	71.7	53.6	50.0	70.1	58.6	45.3	27.3	36.1	55.8	68.8	39.7
18	68.9	72.3	54.7	53.8	58.3	59.3	41.8	26.5	41.8	59.8	71.4	40.6
19	69.1	71.5	56.4	53.6	53.7	59.3	39.6	38.0	36.5	52.0	65.0	42.3
20	69.3	71.5	53.8	53.4	53.7	58.4	37.8	36.8	29.0	50.9	60.0	34.4
21	69.2	70.0	53.8	50.2	53.5	60.9	36.3	39.0	28.4	55.7	66.9	30.9
22	67.0	71.4	54.8	48.9	48.0	62.5	34.6	23.6	26.6	53.2	65.1	43.0
23	65.7	69.7	54.4	53.2	41.4	29.4	33.1	18.8	30.5	58.9	63.2	51.0
24	66.5	70.1	53.3	52.9	41.8	.....	33.4	20.8	31.7	56.3	68.7	39.5
25	64.8	69.8	53.7	47.6	51.2	5.2	42.7	22.1	37.6	45.0	68.0	37.7
26	66.5	71.4	53.6	53.2	51.5	33.9	52.4	25.0	46.8	39.9	64.0	32.4
27	70.2	70.2	53.9	54.4	60.0	33.8	48.6	25.0	31.0	37.2	55.9	43.6
28	69.5	68.7	53.6	53.8	58.7	36.3	42.2	50.8	25.6	43.0	55.0	62.5
29	67.9	63.3	53.7	53.7	54.2	28.9	37.2	.....	30.8	69.5	51.9	57.7
30	69.5	64.9	53.5	62.2	58.5	40.5	39.6	.....	39.4	67.6	49.9	57.4
31	73.8	70.3	.....	53.4	.....	39.8	33.4	.....	50.0	.....	49.2	.....

NOTE.—No flow Dec. 24.

Digitized by Google

Monthly discharge of New Hamakua ditch at Halehaku weir, near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	73.8	64.8	68.9	106	2,130	6,550
August	73.0	63.3	70.1	108	2,170	6,670
September	74.9	52.8	55.2	85.4	1,660	5,080
October	62.2	36.2	49.7	76.9	1,540	4,730
November	70.6	39.8	54.9	84.9	1,650	5,050
December (30 days)	69.7	5.2	51.4	79.5	1,540	4,730
January	55.0	33.1	45.2	69.9	1,400	4,300
February	50.8	18.8	28.1	43.5	788	2,410
March	55.3	25.6	36.9	57.1	1,140	3,510
April	69.5	30.5	49.4	76.4	1,480	4,550
May	71.4	45.3	57.9	89.6	1,800	5,510
June	70.1	30.9	52.7	81.5	1,580	4,850
The year					18,900	57,900

KAUHIKOA[1] DITCH AT OPANA WEIR, NEAR HUELO, MAUI.

LOCATION.—A short distance below crossing of Opana Stream, about 8 miles by road west of Huelo post office.

RECORDS AVAILABLE.—January 1, 1910, to June 30, 1917.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—By 25-foot sharp-crested weir.

CHANNEL AND CONTROL.—Large pool at weir.

EXTREMES OF DISCHARGE.—See monthly-discharge table.

DIVERSIONS.—None above station.

REGULATION.—By gates at frequent intervals.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Records good.

COOPERATION.—Daily-discharge record copied from records of East Maui Irrigation Co.

Daily discharge, in million gallons, of Kauhikoa ditch at Opana weir, near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	June.
1	41.8	47.6	13.4	19.9	22.5	40.2		4.2		
2	31.4	54.3	40.4	21.6	24.1	55.0				13.6
3	29.0	63.3	28.1	18.2	42.0	68.2				4.1
4	20.6	37.3	24.5	16.7	27.5	61.6		8.3		2.5
5	17.3	24.9	23.3	14.3	66.8	49.7		8.2	4.2	.7
6	12.4	16.3	24.9	3.0	62.8	41.1		2.0	1.3	5.2
7	8.4	12.5	50.8		41.5	31.8				2.1
8	3.2	9.9	48.3		38.6	22.9				6.3
9	.9	8.5	31.7		28.2	27.1		5.7		9.6
10	3.9	7.0	35.6		22.5	84.5		1.2		1.6
11	12.6	16.4	28.5		20.3	68.3			1.9	8.0
12	5.1	37.9	26.0	.3	15.1	49.2			3.8	5.5
13	19.1	43.8	23.2	6.9	3.6	38.9				1.2
14	8.3	56.0	22.0			46.5				
15	9.1	37.5	28.8			43.6		1.7		
16	24.4	22.6	23.5		30.8	48.4		1.7		
17	46.2	21.0	19.8	9.0	62.2	65.8			1.5	
18	20.7	19.5	18.4	14.7	23.7	73.3		5.0	6.1	
19	15.0	33.3	58.7	12.9	19.0	69.4			.4	
20	9.4	32.4	31.5	11.8	12.7	60.8				
21	7.5	21.8	26.1	2.2	8.4	87.3				
22	4.2	17.0	26.6		.8	80.8				1.7
23	.5	11.7	31.7	8.5						1.2
24		8.5	32.0	6.8	13.3					
25		7.1	29.5		11.7					
26		6.8	24.5	14.3	13.8					
27	5.3	6.5	22.5	29.9	37.9					
28	5.3	5.8	21.2	16.8	58.8		9.7		7.9	.6
29	4.2	5.0	18.7	22.3	43.7				74.1	2.4
30	7.5	4.5	17.6	46.5	49.6				75.4	.3
31	60.3	7.2		28.3						

NOTE.—No flow on days for which discharge is not given.

[1] New alinement of Old Hamakua ditch west of Halehaku Gulch.

Digitized by Google

Monthly discharge of Kauhikoa ditch at Opana weir, near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July (28 days)	60.3	0.5	15.5	24.0	434	1,330
August	63.3	4.5	22.7	35.	704	2,160
September	58.7	13.4	28.4	43.9	852	2,610
October (21 days)	46.5	.3	15.5	24.0	325	999
November (27 days)	66.8	.8	29.7	46.0	802	2,460
December (22 days)	87.3	22.9	55.2	85.4	1,210	3,730
February (1 day)	.....	.....	.....	.....	10	30
March (9 days)	8.3	1.2	4.22	6.53	38	117
April (10 days)	75.4	.4	17.7	27.4	177	543
June (17 days)	13.6	.3	39.2	60.7	67	2,050
The year	.....	.....	.....	.....	4,620	16,000

LOWRIE DITCH AT OPANA WEIR, NEAR HUELO, MAUI.

LOCATION.—A short distance west of Halehaku Gulch, about 7 miles by road northwest of Huelo post office.

RECORDS AVAILABLE.—January 1, 1910, to June 30, 1917.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by sharp-crested weir 16⅓ feet long, with bottom and end contractions.

CHANNEL AND CONTROL.—Large pool back of weir.

EXTREMES OF DISCHARGE.—See monthly-discharge table.

DIVERSIONS.—None above station.

REGULATION.—By gates at frequent intervals.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Records good.

COOPERATION.—Daily-discharge record copied from records of East Maui Irrigation Co.

Daily discharge, in million gallons, of Lowrie ditch at Opana weir, near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	58.1	58.8	57.7	57.6	52.6	54.4	48.1	27.7	41.2	37.3	52.8	41.5
2	58.2	58.8	56.6	57.5	57.1	57.3	43.4	17.0	27.0	46.6	52.2	52.2
3	58.1	59.0	55.4	55.2	55.8	56.4	46.8	16.7	36.6	31.9	58.1	51.1
4	58.0	58.9	54.9	53.2	56.4	58.6	58.1	15.7	55.8	34.7	57.6	46.4
5	58.0	59.0	58.3	51.3	59.2	59.0	58.6	14.7	49.0	57.0	57.7	53.9
6	58.0	58.8	58.4	52.5	58.8	55.4	58.0	13.9	27.6	53.6	55.4	55.8
7	57.7	58.6	57.8	48.3	58.4	53.2	58.8	13.6	30.4	54.2	55.4	53.1
8	58.3	58.7	58.5	51.9	58.1	52.6	54.5	12.9	43.4	47.5	45.3	54.9
9	58.1	58.1	58.5	50.7	57.9	53.8	54.3	13.0	55.7	44.4	46.0	56.7
10	58.0	58.4	59.1	45.2	57.9	59.4	48.4	12.4	40.4	41.3	42.7	54.7
11	57.3	58.8	58.8	41.0	57.8	59.0	57.4	11.7	30.7	57.4	48.2	56.7
12	54.0	58.8	58.1	43.5	52.2	55.7	58.9	11.8	51.5	50.6	57.6	54.7
13	58.9	59.2	58.1	44.3	49.8	58.7	48.8	11.6	39.1	48.7	50.1	48.1
14	58.9	59.8	56.7	41.3	45.8	46.4	53.7	45.7	39.0	56.7	57.0	46.9
15	58.8	58.9	54.2	51.0	42.5	52.7	39.1	35.4	54.3	50.9	54.7	39.5
16	59.0	58.9	56.9	49.6	57.6	58.9	35.7	27.3	43.4	51.5	55.8	33.7
17	59.2	59.1	51.3	56.3	54.4	59.3	27.0	25.2	34.1	54.5	57.7	31.6
18	58.6	58.7	40.0	55.8	50.9	59.5	21.0	22.9	39.6	51.6	54.7	50.2
19	58.5	59.1	6.7	55.5	53.9	56.8	19.7	39.4	38.0	44.0	57.4	34.7
20	58.4	58.8	11.6	53.2	51.5	20.8	19.3	36.5	33.2	53.6	55.1	32.2
21	58.3	58.8	57.5	47.5	46.0	18.9	18.7	35.8	28.8	43.8	55.9	31.3
22	55.8	58.8	56.7	54.1	46.2	18.3	18.2	20.7	35.0	51.0	50.2	43.2
23	58.6	58.8	58.2	53.3	40.0	23.9	17.0	16.3	33.6	49.4	53.8	38.2
24	58.3	58.8	58.2	50.0	48.8	4.6	18.0	11.3	33.3	33.8	57.4	33.1
25	56.4	58.7	58.1	46.7	49.6	1.6	43.0	10.3	39.0	35.5	57.6	29.4
26	56.7	58.1	58.0	56.1	50.8	1.6	56.1	16.5	47.9	38.8	53.2	27.1
27	54.9	57.9	57.7	56.6	47.1	7.1	42.0	14.8	27.0	36.7	52.3	47.1
28	50.4	58.1	56.4	56.1	56.8	14.8	25.2	52.9	31.1	44.9	55.5	53.7
29	57.8	58.1	54.5	56.2	54.8	6.9	21.1	.....	46.3	61.0	44.8	46.9
30	58.9	55.8	51.0	57.4	58.8	24.7	30.9	.....	49.8	60.1	37.0	25.6
31	58.8	58.0	.....	56.5	.....	39.3	32.4	.....	49.0	.....	35.4	.....

Digitized by Google

Monthly discharge of Lowrie ditch at Opana weir, near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	59.2	50.4	57.6	89.1	1,790	5,480
August	59.8	55.8	58.6	90.7	1,820	5,570
September	59.1	6.7	53.1	82.2	1,590	4,890
October	57.6	41.0	51.8	80.1	1,610	4,930
November	59.2	40.0	52.9	81.8	1,590	4,870
December	59.5	1.6	40.3	62.4	1,250	3,830
January	58.9	17.0	39.7	61.4	1,230	3,780
February	52.9	10.3	21.6	33.4	604	1,860
March	55.8	27.0	39.7	61.4	1,230	3,780
April	61.0	31.9	47.4	73.3	1,420	4,360
May	58.1	35.4	52.4	81.1	1,620	4,990
June	56.7	25.6	44.1	68.2	1,320	4,060
The year	61.0	1.6	46.8	72.4	17,100	52,400

HAIKU DITCH AT PEAHI WEIR, NEAR HUELO, MAUI.

LOCATION.—In Peahi about 8 miles by road northwest of Huelo post office.

RECORDS AVAILABLE.—January 1, 1910, to June 30, 1917.

GAGE.—Friez water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by sharp-crested weir, 16⅓ feet long, with bottom and end contractions.

CHANNEL AND CONTROL.—Large pool at weir.

EXTREMES OF DISCHARGE.—See monthly-discharge table.

DIVERSIONS.—None above station.

REGULATION.—By gates at frequent intervals.

UTILIZATION.—Irrigation of sugar cane.

ACCURACY.—Records good.

COOPERATION.—Daily-discharge record copied from records of East Maui Irrigation Co.

Daily discharge, in million gallons, of Haiku ditch at Peahi weir near Huelo, Maui, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	60.1	73.9	63.9	59.2	54.2	55.5	26.8	2.0	1.4	0.9	82.6	13.7
2	62.2	77.7	63.3	58.3	50.3	64.6	18.3	2.0	1.2	.9	80.3	46.4
3	70.4	84.6	60.6	29.9	68.6	76.3	20.6	2.0	.9	3.3	71.4	36.3
4	69.9	75.3	48.5	28.3	69.7	72.8	70.9	1.9	.9	4.4	53.0	31.3
5	79.1	73.5	49.5	22.1	84.3	58.4	71.0	1.7	.9	34.1	25.3	32.2
6	69.1	71.2	62.4	5.4	76.3	46.9	62.2	1.2	.9	6.5	36.8	58.2
7	47.8	58.9	70.0	4.6	58.7	46.8	69.4	1.0	.9	3.5	29.9	20.2
8	30.6	53.9	77.3	5.1	61.1	42.9	27.9	1.0	2.3	3.1	33.6	54.9
9	23.1	44.1	69.4	6.6	37.4	32.2	6.3	1.0	.9	2.6	22.3	59.5
10	39.6	42.2	69.8	4.7	36.4	76.8	2.8	1.0	.9	2.6	11.2	20.9
11	68.4	65.2	61.4	3.7	34.5	72.9	4.8	1.0	.9	52.1	12.6	55.2
12	59.7	66.2	54.0	10.2	24.8	53.2	2.7	1.0	.9	20.5	32.4	55.1
13	80.1	68.1	46.2	17.1	8.0	65.9	2.6	1.0	.9	8.2	20.8	16.4
14	74.1	87.7	37.4	3.4	6.1	59.6	2.4	1.3	.9	25.3	32.4	14.4
15	74.7	74.1	44.5	4.3	8.5	55.3	2.4	1.2	1.0	38.2	35.1	16.0
16	78.3	68.9	43.9	4.7	81.7	54.5	2.3	1.1	.9	23.9	35.1	25.7
17	85.2	69.7	34.1	54.7	78.3	74.9	2.3	1.1	.9	36.6	67.4	10.6
18	76.7	68.4	39.6	45.1	47.2	81.5	2.1	1.1	.9	30.5	77.1	12.5
19	73.8	71.4	62.6	24.5	28.6	71.3	2.3	1.1	.9	14.2	54.9	9.4
20	61.2	71.4	74.1	15.1	30.0	67.9	2.2	1.1	.9	37.9	21.0	8.2
21	51.8	69.3	53.7	6.4	26.8	68.9	2.2	1.2	.9	20.4	37.0	7.5
22	32.0	68.0	51.0	14.3	7.2	70.2	2.0	1.3	.9	22.9	29.1	26.1
23	26.8	62.8	67.8	30.9	5.8	75.1	1.7	1.3	.9	44.4	55.9	13.1
24	23.1	65.3	67.0	13.0	19.7	45.1	1.6	1.3	.9	31.3	66.5	11.4
25	26.9	56.7	65.8	4.4	26.6	30.0	1.6	1.3	.9	18.5	42.3	10.7
26	34.4	55.7	62.9	54.9	39.6	28.4	1.5	1.3	.9	9.5	17.3	9.1
27	61.6	53.0	48.3	68.7	45.9	30.2	1.3	1.2	.9	8.3	13.6	24.9
28	68.4	58.9	38.6	66.7	68.5	29.9	1.1	1.3	.9	27.5	15.9	37.6
29	49.6	51.9	31.7	53.8	57.5	28.9	1.1	.....	.9	84.4	13.1	23.4
30	66.3	46.0	31.6	77.3	75.7	29.6	1.5	.....	.9	81.1	23.5	26.1
31	85.5	60.3	.....	69.3	.....	37.6	1.6	.....	.9	.....	17.1	.....

Digitized by Google

Monthly discharge of Haiku ditch, at Peihi weir near Huelo, Maui, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	85.5	23.1	58.4	90.4	1,810	5,560
August	87.7	42.2	65.0	101	2,010	6,180
September	77.3	31.6	55.0	85.1	1,650	5,060
October	77.3	3.4	28.0	43.3	867	2,660
November	84.3	5.8	43.9	67.9	1,320	4,040
December	81.5	28.4	55.0	85.1	1,700	5,230
January	71.0	1.1	13.5	20.9	420	1,280
February	2.0	1.0	1.29	2.00	36	111
March	2.3	.9	.97	1.50	30	92
April	84.4	.9	23.3	36.1	698	2,150
May	82.6	11.2	37.6	58.2	1,170	3,580
June	59.5	7.5	26.2	40.5	787	2,410
The year	87.7	.9	34.3	53.1	12,500	38,400

MISCELLANEOUS MEASUREMENTS.

Measurements of streams and ditches on the island of Maui at points other than regular gaging stations are listed below:

Miscellaneous measurements on Maui for the year ending June 30, 1917.

Date.	Stream.	Locality.	Gage height (feet).	Discharge.	
				Second-feet.	Million gallons per day.
July 28	Olowalu ditch	In tailrace of power house	0.70	7.6	4.9
July 24	North Waiehu	¼ mile below intake of North Waiehu ditch.	.85	.3	.2
Aug. 12	do	do	.54	.35	.25
Sept. 15	do	do	.53	.21	.15
Oct. 16	do	do	.48	.12	.08
Dec. 13	do	do	.94	.98	.65
Jan. 26	do	do	.59	.34	.22
Feb. 16	do	do	.33	.05	.03
May 24	do	do	.71	.37	.24
Dec. 11	Spreckels ditch	Just east of Puohakamoa Stream		33.3	21.5

ISLAND OF HAWAII.

UPPER HAMAKUA DITCH AT PUUALALA AND RESERVOIR NO. 3 WEIRS, NEAR KUKUIHAELE, HAWAII.

LOCATION.—Puualala weir is in Lalakea tract, adjacent to forest reserve and close to Kaala Mountain and Pacific sugar mill fence. Reservoir No. 3 weir is on a branch from main ditch just before it enters reservoir No. 3, about 1 mile south of Puualala or main weir.

RECORDS AVAILABLE.—January 1, 1913, to June 30, 1917. Records given herewith show the combined flow of the main ditch and its diversion to reservoir No. 3 which occurs above the main weir.

GAGE.—Watson water-stage recorder at each weir.

DISCHARGE MEASUREMENTS.—Made by sharp-crested weirs with good stilling basins above.

EXTREMES OF DISCHARGE.—See monthly-discharge table.

DIVERSIONS.—This ditch diverts all natural run-off from upper headwaters of Waipio Gulch.

UTILIZATION.—Irrigation of sugar cane and domestic supply.

ACCURACY.—Records good.

COOPERATION.—Records furnished by the Hawaiian Irrigation Co.

Digitized by Google

Daily discharge, in million gallons, of Upper Hamakua ditch, at Puualala and reservoir No. 3 weirs, near Kukuihaele, Hawaii, for the year ending June 30, 1917.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	15.8	16.5	12.8	23.5	31.0	1.0	31.1	0.8	13.6	13.9	15.8	7.3
2	9.5	22.5	30.8	18.5	17.2	.5	.....	.6	3.5	7.8	5.5	14.8
3	6.8	28.0	15.0	8.5	11.5	13.5	.....	.6	15.4	7.3	4.3	6.5
4	9.8	13.8	8.5	4.5	6.0	22.2	.....	.6	18.0	4.7	3.6	5.0
5	24.5	10.8	12.2	2.5	3.8	7.5	31.1	.6	9.7	3.9	2.9	3.7
6	24.5	7.0	19.2	2.5	19.8	5.2	12.0	.6	4.2	11.0	5.2	6.6
7	11.2	7.0	19.0	1.8	12.8	3.2	8.5	.5	2.0	17.9	3.2	9.7
8	6.5	7.5	11.8	1.8	6.0	2.0	5.8	.7	1.8	5.6	3.0	25.3
9	4.2	13.0	9.5	1.8	4.8	1.8	22.0	.6	1.8	3.6	1.9	18.8
10	10.5	20.0	7.5	1.5	3.5	35.5	8.1	.7	1.2	8.0	2.4	9.2
11	20.5	8.8	5.5	.5	3.5	33.2	11.2	.7	9.1	16.8	6.1	14.8
12	13.5	19.5	10.5	.8	4.8	12.0	4.7	.5	10.0	15.3	5.5	13.1
13	7.8	18.2	4.8	3.5	3.5	7.0	1.9	.4	9.0	9.7	5.7	5.2
14	21.2	20.2	3.2	2.2	2.0	7.0	14.5	7.1	8.7	13.7	5.6	6.4
15	10.0	19.5	1.8	3.0	6.0	10.0	7.3	4.9	3.6	14.7	5.2	5.5
16	9.2	9.2	2.2	1.8	28.8	23.5	2.4	1.7	6.8	11.4	3.9	11.7
17	22.2	8.0	1.8	1.2	18.5	26.0	6.4	.9	1.6	12.1	13.5	7.4
18	17.2	14.5	9.2	3.0	10.0	27.2	16.9	.5	2.3	15.4	18.3	6.2
19	13.0	11.8	30.5	5.2	5.5	26.2	22.6	.5	1.9	15.6	11.5	15.5
20	16.2	11.2	13.5	8.0	2.5	19.2	23.4	1.6	1.2	11.8	7.4	13.7
21	17.0	10.5	11.8	4.2	3.0	35.5	11.1	21.7	.8	18.2	20.3	11.4
22	7.2	9.0	13.8	3.5	3.0	44.2	6.0	4.8	.7	13.4	26.4	25.6
23	7.0	11.5	20.0	10.5	1.8	43.8	3.7	1.9	6.6	8.9	15.7	16.9
24	6.5	9.2	20.0	8.5	1.8	24.0	2.2	1.1	17.7	7.7	10.8	5.6
25	14.2	5.0	20.0	6.0	1.8	7.0	1.8	8.0	14.6	6.8	7.3	3.2
26	14.8	3.8	12.5	7.2	3.0	6.8	2.0	.5	4.6	6.2	5.4	3.0
27	24.0	4.5	15.5	17.2	15.8	6.5	15.8	.3	2.6	3.9	5.2	2.6
28	19.0	5.0	14.8	11.8	13.5	11.0	5.7	27.5	5.9	2.7	5.6	1.3
29	15.8	12.0	11.2	5.0	11.0	29.5	3.4	.....	14.9	5.6	3.7	1.3
30	19.2	6.2	13.0	4.5	6.5	19.0	2.8	.....	18.0	19.1	2.9	2.3
31	26.5	5.0	.....	6.2	.....	15.8	3.4	.....	18.0	.....	1.6	.....

NOTE.—No flow Jan. 2–4.

Monthly discharge of Upper Hamakua ditch at Puualala and reservoir No. 3 weirs, near Kukuihaele, Hawaii, for the year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	26.5	4.2	14.4	22.3	445	1,370
August	28.0	3.8	11.9	18.4	369	1,130
September	30.8	1.8	12.7	19.6	382	1,170
October	23.5	.5	5.83	9.02	181	555
November	31.0	1.8	8.76	13.6	263	806
December	44.2	.5	17.0	26.3	527	1,620
January (28 days)	31.1	1.8	10.3	15.9	288	885
February	27.5	.3	3.25	5.03	91	279
March	18.0	.7	7.41	11.5	230	705
April	19.1	2.7	10.4	16.1	313	958
May	26.4	1.6	7.59	11.7	235	722
June	25.6	1.3	9.17	14.2	275	844
The year	.....	.....	.....	.....	3,600	11,000

LOWER HAMAKUA DITCH AT MAIN WEIR, NEAR KUKUIHAELE, HAWAII.

LOCATION.—Just below portal of last tunnel from Waipio Gulch, half a mile southwest of Pacific sugar mill, at Kukuihaele. This ditch diverts all natural run-off from headwaters of the Waipio basin below the Upper Hamakua ditch.

RECORDS AVAILABLE.—July 18, 1910, to June 30, 1917.

GAGE.—Watson water-stage recorder.

DISCHARGE.—Measured by weir consisting of six 5-foot panels, sharp-crested and with a good stilling basin above. Current-meter measurements made in ditch below weir have checked determinations by weir formulas within 2 per cent.

Digitized by Google

EXTREMES OF DISCHARGE.—See monthly-discharge table.
UTILIZATION.—Irrigation of sugar cane and domestic supply.
ACCURACY.—Records good.
COOPERATION.—Records furnished by the Hawaiian Irrigation Co.

Daily discharge, in million gallons, of Lower Hamakua ditch at main weir, near Kukuihaele, Hawaii, for the year ending June 30, 1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	53.2	53.0	47.0	40.2	59.0	34.2	34.9	32.3	41.4	40.5	39.2	38.1
2	49.0	55.5	60.2	55.2	53.2	33.8	34.9	31.8	34.6	41.4	37.1	42.7
3	46.8	55.5	54.5	46.0	48.2	49.5	37.4	31.3	39.9	36.6	34.1	36.1
4	47.5	53.8	47.8	40.5	38.8	53.5	35.6	31.3	41.5	34.9	33.1	35.3
5	54.0	43.5	49.5	38.5	40.5	40.5	35.7	31.1	38.9	37.9	33.0	33.0
6	52.8	49.5	52.5	37.5	59.5	36.0	39.2	31.1	34.4	40.1	32.7	39.7
7	48.8	42.2	55.5	36.8	49.5	34.0	39.2	31.1	32.5	43.2	31.5	46.3
8	46.5	49.2	50.0	36.2	40.5	35.2	38.9	30.5	32.1	34.1	31.4	54.2
9	42.5	50.5	46.8	35.8	42.0	32.8	38.4	30.6	32.0	38.2	31.4	49.6
10	45.2	54.0	45.5	35.5	36.8	51.5	38.2	30.6	31.3	37.6	34.2	41.9
11	53.2	57.2	42.5	34.8	38.0	40.0	38.7	30.5	35.7	39.1	36.5	45.1
12	52.5	58.5	50.0	35.0	41.2	38.2	38.9	30.1	34.9	43.5	35.6	46.7
13	45.0	60.5	41.5	35.0	36.2	39.2	38.5	29.9	34.5	37.3	35.9	37.1
14	53.0	52.5	39.0	34.8	34.5	37.5	38.0	35.8	36.4	42.2	34.2	33.0
15	43.5	60.5	38.0	37.0	34.2	42.0	36.0	33.8	32.8	47.1	35.4	31.9
16	45.5	56.2	38.0	37.0	60.8	41.2	35.4	31.9	35.1	42.5	32.6	36.3
17	54.5	51.0	36.8	34.5	57.0	41.5	35.0	31.2	33.7	43.2	37.1	35.5
18	53.2	55.5	42.2	34.8	47.5	35.5	34.7	30.9	31.7	41.8	35.4	33.2
19	49.2	55.0	56.0	38.8	41.2	34.5	34.5	30.1	31.8	47.4	36.6	39.0
20	50.5	50.0	49.0	40.0	38.8	35.5	40.2	31.3	31.5	40.4	34.2	39.6
21	52.0	51.8	44.2	43.8	36.0	34.8	36.6	40.8	30.6	47.7	43.9	33.2
22	44.8	49.8	48.0	36.0	34.5	34.8	36.2	38.2	29.9	50.3	51.7	42.9
23	45.2	50.5	53.2	41.0	34.2	34.2	34.4	30.2	35.1	43.2	47.0	39.3
24	48.2	49.0	52.2	42.8	33.8	36.5	34.0	30.9	44.2	35.8	38.7	36.8
25	48.0	46.8	54.2	36.2	33.5	35.0	33.8	30.5	40.6	33.8	37.4	34.2
26	49.0	41.2	50.5	35.5	34.5	36.2	33.5	29.6	33.2	32.8	34.2	32.9
27	53.2	41.0	52.5	33.8	38.0	36.0	33.4	29.7	31.3	32.2	34.6	31.6
28	43.5	44.5	52.5	20.0	54.2	34.5	33.0	43.3	34.6	31.6	35.9	31.8
29	36.8	50.2	50.2	37.5	39.2	35.0	33.3	.....	38.7	33.3	31.7	32.9
30	50.2	46.2	46.2	36.2	34.8	34.5	33.8	.....	40.7	36.0	31.1	33.6
31	51.0	46.2	.....	44.5	.....	35.0	33.5	.....	40.7	.....	30.9	.....

Monthly discharge of Lower Hamakua ditch at main weir, near Kukuihaele, Hawaii, for year ending June 30, 1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
July	54.5	36.8	48.7	75.4	1,510	4,630
August	60.5	41.0	51.0	78.9	1,580	4,850
September	60.2	36.8	48.2	74.6	1,450	4,440
October	55.2	20.0	37.8	58.5	1,170	3,600
November	60.8	33.5	42.3	65.4	1,270	3,890
December	53.5	32.8	37.8	58.5	1,170	3,600
January	40.2	33.0	36.1	55.9	1,120	3,430
February	43.3	29.6	32.2	49.8	900	2,770
March	44.2	29.9	35.4	54.8	1,100	3,370
April	50.3	31.6	39.5	61.1	1,190	3,640
May	51.7	30.9	35.8	55.4	1,110	3,410
June	54.2	31.6	38.1	58.9	1,140	3,510
The year	60.8	20.0	40.3	62.4	14,700	45,100

KOHALA DITCH AT AWINI WEIR, NEAR KOHALA, HAWAII.

LOCATION.—At elevation 1,880 feet in east branch of Honokanenui Gulch, Kohala district.
RECORDS AVAILABLE.—July 1, 1907, to June 30, 1917.
GAGE.—Vertical staff showing head on weir.
DISCHARGE MEASUREMENTS.—Measured by a sharp-crested weir consisting of three 5-foot panels.

Digitized by Google

EXTREMES OF DISCHARGE.—See monthly-discharge tables.
UTILIZATION.—For irrigation of sugar cane and for domestic supply.
ACCURACY.—Records good.
COOPERATION.—Records furnished by the Kohala Ditch Co.

Daily discharge, in million gallons, of Kohala ditch at Awini weir, near Kohala, Hawaii, for the years ending June 30, 1914–1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1914.												
1	16.9	3.3	5.2	0.9	.....	6.6	5.2	15	1.5	7.0	7.0	17
2	19.5	4.4	3.7	.9	.....	9.8	4.4	13	1.2	11	6.6	17
3	16.9	8.4	4.8	.9	11.5	9.8	4.0	10	.9	7.9	5.8	16
4	14.6	6.2	4.8	.9	18.3	10.5	10	11	.9	7.0	9.8	16
5	12.5	5.8	3.7	.5	13.6	20.7	21	9.8	.9	7.0	21	21
6	20.7	5.2	3.0	.5	10.5	20.7	17	9.3	.9	5.2	21	18
7	20.7	4.0	6.2	.5	7.0	20.7	10	8.4	.9	16	21	17
8	16.9	4.0	6.2	1.5	5.2	20.7	9.3	8.4	.9	14	21	16
9	14.6	3.3	5.2	1.2	20.1	20.1	21	7.5	.9	11	17	21
10	12.0	4.0	6.2	2.1	20.1	19.5	21	7.0	17	11	21	21
11	10.5	4.0	7.9	1.5	20.1	16.9	18	6.6	12	16	21	21
12	14.6	16.9	7.0	.9	20.1	14.1	21	6.2	7.0	11	21	18
13	16.9	20.7	7.9	.7	15.2	12.5	21	6.2	16	7.9	21	17
14	14.6	20.7	6.2	.5	12.0	11.5	18	6.2	14	5.2	21	16
15	14.6	16.9	4.8	.5	10.5	20.7	17	5.2	9.3	4.4	21	16
16	12.5	15.2	4.0	1.5	12.0	20.7	10	5.2	6.6	3.7	21	15
17	10.5	12.5	3.7	1.2	20.1	20.7	14	4.8	11	3.3	21	21
18	8.4	7.5	7.9	.9	20.1	20.7	13	4.0	10	3.3	21	21
19	8.4	5.8	11.5	.7	20.1	16.9	11	3.3	6.2	21	21	21
20	7.5	4.8	7.0	.5	16.3	14.1	11	3.0	4.8	21	21	21
21	6.6	4.8	5.2	.5	20.1	12.5	8.8	3.0	4.4	21	21	18
22	7.9	4.0	4.4	.5	14.6	10.5	21	3.0	4.0	21	17	21
23	7.5	3.3	3.3	.5	13.6	15.7	21	2.7	3.3	21	17	21
24	6.6	2.7	2.7	.5	13.6	14.1	17	2.4	2.7	21	15	21
25	5.8	4.0	1.8	.5	12.5	12.5	14	2.4	18	21	15	21
26	6.2	2.1	1.8	.5	12.5	10.5	10	2.0	17	16	15	21
27	5.8	2.1	1.8	.3	11.0	9.8	8.8	2.0	11	13	14	21
28	5.8	2.1	1.2	.2	9.8	7.9	11	1.8	8.4	13	21	18
29	5.2	2.1	1.2	.....	8.4	6.6	21	.....	10	9.8	17	21
30	4.4	5.8	1.2	.....	7.5	6.2	21	.....	17	8.4	15	18
31	4.4	5.8	.....	.....	.....	6.2	17	.....	10	.....	15	.....
1915.												
1	18	18	21	21	21	19	15	16	7.5	17	17	5.2
2	21	18	21	21	18	18	15	16	6.6	15	16	10
3	18	21	21	21	16	16	16	13	10	13	15	9.8
4	21	21	21	18	14	15	21	9.3	10	10	13	7.9
5	21	21	21	18	13	18	21	16	10	8.4	13	5.2
6	21	21	21	21	10	16	17	16	14	7.5	10	5.2
7	21	21	21	21	9.3	15	15	15	14	8.4	9.8	4.8
8	21	21	19	21	9.3	13	15	15	14	8.4	9.8	4.8
9	21	21	18	21	8.8	13	13	14	14	21	9.3	4.8
10	21	21	18	21	8.4	11	13	19	11	21	16	4.8
11	21	21	17	18	8.4	10	21	21	8.4	21	18	4.8
12	21	21	16	17	8.4	18	17	21	9.3	18	18	4.8
13	21	21	17	15	7.9	21	15	21	9.3	16	16	4.8
14	21	21	17	14	7.9	21	13	21	21	13	10	6.2
15	21	21	16	18	21	18	11	17	21	10	10	5.8
16	19	21	16	17	21	16	10	17	17	10	10	9.3
17	18	21	17	17	17	15	9.3	17	14	21	10	12
18	17	21	21	18	14	13	8.4	21	13	18	9.3	9.2
19	16	21	21	17	21	10	7.5	21	9.3	18	9.3	9.2
20	15	21	21	16	21	21	7.0	21	8.8	21	9.3	13
21	*15	21	19	16	19	21	6.6	17	7.5	18	9.3	12
22	18	21	18	15	18	18	12	16	6.6	21	9.3	8.4
23	18	21	17	14	18	16	12	15	6.6	21	9.3	21
24	21	21	16	13	21	15	11	15	6.6	18	9.3	21
25	21	21	16	13	21	21	11	14	6.6	18	9.1	*18
26	21	21	16	11	21	21	10	10	5.8	21	7.0	18
27	21	21	21	18	21	21	8.8	10	5.8	21	7.0	21
28	21	21	21	18	21	21	8.4	9.8	4.8	18	7.6	17
29	21	21	19	17	21	21	7.9	.....	4.8	18	7.6	11
30	21	21	18	15	21	18	7.0	.....	4.8	18	5.8	9.8
31	21	21	.....	18	.....	17	7.6	.....	4.4	.....	5.8	.....

Digitized by Google

Daily discharge, in million gallons, of Kohala ditch at Awini weir, near Kohala, Hawaii, for the years ending June 30, 1914–1917—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1916.												
1	17	14	3.3	21	17	8.4	12	7.5	4.4	6.2	21	21
2	16	14	3.3	21	17	5.7	11	7.5	4.4	6.2	21	21
3	13	16	3.3	15	17	21	12	7.5	3.3	6.2	21	21
4	10	16	3.3	10	21	17	14	5.2	3.0	5.8	21	21
5	13	15	3.3	7.9	17	14	21	4.4	12	4.8	21	18
6	15	14	3.3	5.2	15	12	17	3.7	12	4.4	21	16
7	16	11	2.7	5.2	13	21	15	3.7	12	4.4	21	12
8	21	8.4	2.7	4.4	10	17	21	3.0	9.3	4.0	21	10
9	21	7.9	2.0	4.4	17	14	21	3.0	5.2	17	21	9.3
10	16	6.6	2.0	6.6	17	12	21	3.0	3.0	14	21	8.8
11	14	6.6	2.0	9.3	17	12	21	2.4	3.0	10	18	7.9
12	13	5.8	4.8	8.8	15	10	17	2.1	3.0	7.5	17	18
13	11	5.8	5.2	6.2	15	8.4	15	2.1	18	4.0	16	16
14	11	5.2	3.3	4.4	15	7.9	18	2.1	17	3.7	15	21
15	14	5.2	3.7	3.7	17	7.0	17	1.8	21	17	14	18
16	21	5.2	5.2	3.7	15	7.9	15	1.5	15	16	12	17
17	21	4.8	3.3	3.0	11	9.3	17	1.5	10	14	16	18
18	16	4.4	3.0	2.7	13	9.3	21	1.5	10	14	14	21
19	11	4.4	3.0	3.7	21	9.3	21	1.5	8.4	21	12	18
20	10	4.0	7.0	3.7	21	21	21	1.5	8.4	21	12	18
21	8.4	4.0	5.8	14	21	21	17	1.5	7.0	21	10	21
22	7.0	4.4	5.2	14	17	21	15	1.5	9.3	17	9.8	21
23	9.3	4.8	5.2	11	14	17	12	1.5	12	12	12	21
24	9.3	4.4	2.7	21	12	14	10	1.2	8.8	16	10	18
25	6.6	4.0	2.7	17	10	10	10	.9	8.8	15	9.8	17
26	6.6	4.0	2.0	13	10	21	18	.9	8.8	14	9.3	21
27	11	4.0	5.8	13	8.8	21	10	10	8.8	12	7.9	21
28	16	4.0	14	21	10	17	12	7.9	8.8	21	7.5	21
29	11	4.0	15	21	10	12	10	4.8	6.2	21	16	21
30	13	4.0	21	21	8.8	10	9.8	.....	8.8	21	17	21
31	16	4.0	.....	21	.....	14	8.8	.....	8.8	.....	17	.....
1917.												
1	20.7	20.7	7.5	9.3	16.9	5.8	12.5	7.9	14.6	20.7	13.6	4.0
2	16.9	20.7	20.7	8.4	14.1	5.2	10.5	6.2	11.5	11.5	9.8	7.0
3	11.0	20.7	14.6	7.5	11.0	16.9	8.8	6.2	16.9	11.0	6.6	5.8
4	12.5	20.7	12.5	6.6	7.9	12.5	20.7	4.8	14.6	11.0	4.4	6.2
5	12.5	16.9	10.5	5.8	7.9	8.8	20.7	4.8	11.5	11.5	4.4	5.2
6	12.5	14.6	9.3	5.2	14.6	6.6	18.9	4.0	9.3	11.5	2.7	3.7
7	11.0	14.6	14.6	4.8	12.5	5.2	16.9	4.0	7.5	13.6	2.7	5.2
8	10.5	18.3	12.0	4.8	8.8	4.4	14.1	4.0	5.2	12.0	2.1	10.5
9	9.8	16.9	10.5	4.8	6.6	3.7	11.0	3.3	4.8	8.4	2.1	10.5
10	9.3	16.9	11.0	3.7	4.0	20.7	9.8	3.3	4.4	9.3	2.1	9.8
11	14.6	20.7	9.8	3.3	3.7	16.9	10.5	3.3	4.8	11.0	2.1	9.8
12	12.5	20.7	9.8	3.3	3.7	12.5	9.8	3.0	7.0	11.5	2.1	9.8
13	11.0	20.7	8.8	3.3	3.3	11.0	10.5	3.0	6.2	8.8	2.1	7.9
14	20.7	20.7	7.9	3.3	3.3	8.4	8.4	3.3	7.9	7.5	2.7	6.2
15	16.9	20.7	6.6	3.3	3.3	8.8	7.4	3.3	6.6	11.0	2.7	5.2
16	18.9	16.9	5.8	3.3	16.9	10.5	7.0	3.3	9.8	11.5	2.1	3.7
17	20.7	15.7	4.8	2.7	14.1	16.9	7.0	3.0	7.5	13.6	4.8	3.3
18	20.7	20.7	5.8	2.4	10.5	20.7	7.0	2.7	6.6	11.5	10.5	1.5
19	18.9	16.9	16.9	2.7	9.3	20.7	6.6	2.7	6.6	13.6	12.5	5.2
20	16.9	14.1	14.6	2.7	7.0	20.7	6.6	2.5	4.4	12.0	9.3	5.2
21	14.6	12.5	10.5	2.7	6.2	20.7	6.2	10.5	4.4	12.0	9.3	5.2
22	14.6	10.5	9.3	2.7	6.2	20.7	6.2	7.9	4.0	12.5	14.1	7.9
23	12.5	8.8	9.3	3.3	6.2	20.7	5.8	5.8	3.7	12.5	10.5	8.4
24	11.0	7.9	9.3	5.8	5.2	20.7	5.8	4.0	15.7	11.0	9.8	11.0
25	9.3	7.5	10.5	4.8	4.4	16.9	5.8	4.0	11.0	8.4	8.4	9.3
26	9.3	7.5	9.3	6.6	5.8	14 6	5.8	3.3	7.4	5.8	6.2	5.2
27	20.7	7.5	9.3	6.6	8.4	11 0	5.8	3.3	7.4	5.8	6.2	3.7
28	20.7	7.5	9.3	6.6	14.6	11.0	5.8	16.9	7.4	7.5	4.8	3.7
29	16.9	7.9	9.3	5.2	9.3	20.7	5.8	.....	8.8	5.8	4.8	3.7
30	20.7	7.9	8.8	6.6	6.6	20.7	10.5	.....	20.7	11.0	4.8	3.3
31	20.7	7.9	.....	10.5	.....	15.7	8.4	.....	16.9	.....	4.4	.....

NOTE.—No flow Oct. 29 to Nov. 2, 1913.

Digitized by Google

Monthly discharge of Kohala ditch at Awini weir, near Kohala, Hawaii, for years ending June 30, 1914–1917.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
1914.						
July	20.7	4.4	11.3	17.5	350	1,080
August	20.7	2.1	6.85	10.6	212	652
September	11.5	1.2	4.72	7.30	142	435
October (28 days)	2.1	.2	.80	1.24	22	69
November (28 days)	20.1	5.2	14.2	22.0	396	1,220
December	20.7	6.2	14.2	22.0	440	1,350
January	21	4.0	14.4	22.3	448	1,370
February	15	1.8	6.05	9.36	169	520
March	18	.9	7.38	11.4	229	702
April	21	3.3	12.0	18.6	359	1,100
May	21	5.8	17.5	27.1	543	1,660
June	21	15	18.9	29.2	568	1,740
The year					3,880	11,900
1915.						
July	21	15	19.8	30.6	613	1,880
August	21	18	20.8	32.2	645	1,980
September	21	16	18.7	28.9	562	1,720
October	21	11	17.4	26.9	539	1,660
November	21	7.9	15.9	24.6	477	1,460
December	21	10	17.0	26.3	527	1,620
January	21	6.6	12.3	19.0	382	1,170
February	21	9.3	16.2	25.1	454	1,390
March	21	4.4	9.89	15.3	306	941
April	21	7.5	16.3	25.2	488	1,500
May	18	5.8	10.8	16.7	336	1,030
June	21	4.8	9.96	15.4	299	917
The year	21	4.4	15.4	23.8	5,630	17,300
1916.						
July	21	3.6	13.4	20.7	414	1,270
August	16	4.0	7.09	11.0	220	675
September	21	2.0	4.97	7.69	149	458
October	21	2.7	10.9	16.9	337	1,040
November	21	8.8	14.8	22.9	443	1,360
December	21	5.7	13.6	21.0	422	1,290
January	21	8.8	15.5	24.0	481	1,470
February	10	.9	3.33	5.15	97	297
March	21	3.0	8.98	13.9	278	854
April	21	3.7	12.4	19.2	371	1,140
May	21	7.5	15.6	24.1	482	1,480
June	21	7.9	17.8	27.5	534	1,640
The year	21	.9	11.6	17.9	4,230	13,000
1917.						
July	20.7	9.3	15.1	23.4	470	1,440
August	20.7	7.5	14.9	23.1	462	1,420
September	20.7	4.8	10.3	15.9	309	948
October	10.5	2.4	4.92	7.61	153	468
November	16.9	3.3	8.41	13.0	252	774
December	20.7	3.7	13.9	21.5	430	1,320
January	20.7	5.8	9.57	14.8	297	910
February	16.9	2.5	4.80	7.43	134	412
March	20.7	3.7	8.87	13.7	275	844
April	20.7	5.8	10.8	16.7	325	994
May	14.1	2.1	5.96	9.22	185	567
June	11.0	1.5	6.24	9.65	187	574
The year	20.7	1.5	9.53	14.7	3,480	10,700

KOHALA DITCH AT NIULII WEIR, NEAR KOHALA, HAWAII.

LOCATION.—At elevation 1,000 feet, 3½ miles south of Niulii, Kohala district.

RECORDS AVAILABLE.—July 1, 1907, to June 30, 1917.

GAGE.—Vertical staff showing head on weir.

DISCHARGE MEASUREMENTS.—Measured by sharp-crested weir consisting of three 5-foot panels.

EXTREMES OF DISCHARGE.—See monthly-discharge table.

Digitized by Google

Utilization.—For irrigation of sugar cane and for domestic supply.
Accuracy.—Records good.
Cooperation.—Records furnished by Kohala Ditch Co.

Daily discharge, in million gallons, of Kohala ditch at Niulii weir, near Kohala, Hawaii, for the years ending June 30, 1914–1917.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1914.												
1	10.6	9.9	9.5	6.8	6.0	9.9	16	27	9.9	18	18	27
2	8.0	10.2	8.2	6.3	6.0	13.0	16	25	9.3	27	18	27
3	10.6	12.0	8.5	6.3	14.7	12.2	14	24	8.6	22	16	27
4	12.8	11.8	8.5	6.8	9.1	13.1	24	27	8.6	18	20	27
5	14.9	11.5	8.2	7.3	13.9	6.8	27	24	8.6	18	27	27
6	6.8	10.6	8.2	7.3	10.6	6.8	27	22	8.6	16	27	27
7	6.8	9.2	10.3	6.7	9.5	6.8	24	21	8.6	27	27	27
8	10.6	9.2	11.1	7.1	8.1	6.8	23	21	8.6	27	27	27
9	12.8	9.2	10.6	7.4	6.1	7.4	27	19	8.6	26	27	27
10	12.4	9.2	11.1	14.4	7.4	8.0	27	16	27	25	27	27
11	11.5	9.2	14.0	8.4	7.4	10.6	27	16	23	27	27	27
12	12.8	10.6	11.7	9.0	7.4	13.3	27	16	16	25	27	27
13	10.6	6.8	11.6	8.0	12.3	14.9	27	16	27	20	27	27
14	12.8	6.8	9.6	7.3	13.3	16.0	27	16	27	16	27	27
15	12.8	10.6	8.5	7.3	11.5	6.8	27	15	20	15	27	27
16	10.3	12.3	7.8	6.2	11.6	6.8	24	16	16	14	27	27
17	11.5	12.8	7.5	6.5	7.4	6.8	27	14	24	13	27	27
18	13.6	12.1	14.0	6.8	7.4	6.8	27	13	21	13	27	27
19	12.8	10.7	16.0	7.1	7.4	10.6	25	13	15	27	27	27
20	12.1	9.9	10.2	7.3	11.1	13.3	27	12	13	27	27	27
21	12.2	9.9	8.8	7.3	7.4	14.9	24	12	13	27	27	27
22	14.0	9.2	8.1	7.3	12.8	15.6	27	12	12	27	27	27
23	14.5	9.2	7.2	7.3	13.9	11.7	27	11	11	27	27	27
24	13.0	9.2	7.2	8.2	13.9	13.3	27	11	9.9	27	27	27
25	10.7	9.2	6.9	8.2	14.9	12.8	27	11	27	27	27	27
26	12.6	9.1	7.5	6.7	14.9	13.1	24	11	27	27	27	27
27	11.5	8.5	6.9	6.8	16.5	12.2	24	11	23	26	27	27
28	11.5	8.5	6.5	7.0	13.8	11.6	25	11	20	24	27	27
29	12.1	9.1	7.4	6.6	12.8	11.4	27	.....	24	23	27	27
30	11.3	10.0	7.4	6.6	11.3	11.1	27	.....	27	19	27	27
31	11.3	10.0	.....	6.6	.....	11.1	27	.....	24	.....	27	.....
1915.												
1	27	27	27	27	27	27	27	27	24	27	27	16
2	27	27	27	27	27	27	27	27	23	27	27	24
3	27	27	27	27	27	27	27	24	24	24	27	24
4	27	27	27	27	27	27	27	20	24	21	27	20
5	27	27	27	27	27	27	27	27	24	20	27	16
6	27	27	27	27	27	27	27	27	27	19	25	16
7	27	27	27	27	27	27	27	27	27	20	22	16
8	27	27	27	27	27	27	27	27	27	20	26	16
9	27	27	27	27	26	27	27	27	27	24	24	16
10	27	27	27	27	23	27	27	27	24	27	27	16
11	27	27	27	27	23	27	27	27	22	27	27	16
12	27	27	27	27	23	27	27	27	25	27	27	16
13	27	27	27	27	22	27	27	27	24	27	26	16
14	27	27	27	27	22	27	27	27	27	24	23	19
15	27	27	27	27	27	27	27	27	27	22	25	17
16	27	27	27	27	27	27	27	27	27	22	25	23
17	27	27	27	27	27	27	27	27	27	27	25	26
18	27	27	27	27	27	27	27	27	27	27	25	22
19	27	27	27	27	27	27	25	27	25	27	22	22
20	27	27	27	27	27	27	24	27	24	27	22	27
21	27	27	27	27	27	27	24	27	23	27	22	26
22	27	27	27	27	27	27	25	27	22	27	22	20
23	27	27	27	27	27	27	26	27	22	27	22	27
24	27	27	27	24	27	27	26	27	22	27	22	27
25	27	27	27	24	27	27	27	27	22	27	20	27
26	27	27	27	24	27	27	25	25	21	27	19	27
27	27	27	27	27	27	27	24	27	21	27	19	27
28	27	27	27	27	27	27	24	26	19	27	18	27
29	27	27	27	27	27	27	22	.....	19	27	18	24
30	27	27	27	27	27	27	20	.....	19	27	17	24
31	27	27	.....	27	.....	27	19	.....	18	.....	17	.....

Digitized by Google

Daily discharge, in million gallons, of Kohala ditch at Niulii weir, near Kohala, Hawaii, for the years ending June 30, 1914–1917—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1916.												
1	27	27	13	27	27	24	26	22	16	18	27	27
2	27	27	13	27	27	22	25	22	16	17	27	27
3	25	27	13	27	27	27	27	22	14	17	27	27
4	23	27	13	24	27	27	27	20	13	16	27	27
5	26	27	13	18	27	27	27	19	26	15	27	27
6	27	27	13	15	27	27	27	18	26	14	27	27
7	27	27	12	15	27	27	27	18	24	14	27	27
8	27	22	12	13	25	27	27	16	20	13	27	26
9	27	21	11	13	27	27	27	16	16	27	27	25
10	27	19	11	19	27	25	27	16	13	27	27	24
11	27	19	11	21	27	25	27	16	13	23	27	24
12	26	17	16	20	27	24	27	15	13	17	27	27
13	24	17	17	16	27	22	27	14	27	14	27	27
14	24	16	14	15	27	21	27	14	27	13	27	27
15	27	16	15	14	27	20	27	13	27	27	27	27
16	27	16	16	14	27	21	27	12	27	27	27	27
17	27	16	14	13	26	24	27	12	24	27	27	27
18	27	15	13	13	27	24	27	12	24	27	27	27
19	24	15	13	14	27	24	27	12	19	27	27	27
20	23	14	20	14	27	27	27	12	19	27	27	27
21	20	14	16	27	27	27	27	12	17	27	27	27
22	18	15	16	27	27	27	27	12	20	27	27	27
23	20	16	16	25	27	27	27	12	26	25	26	27
24	20	15	12	27	27	27	27	12	23	27	27	27
25	17	14	12	27	27	23	27	11	23	27	27	27
26	17	14	11	24	25	27	27	11	23	26	26	27
27	24	14	16	27	24	27	27	27	23	25	25	27
28	27	14	24	27	27	27	27	22	23	27	24	27
29	24	14	26	27	26	24	27	16	16	27	27	27
30	26	14	27	27	25	24	26	.....	23	27	27	27
31	27	14	.....	27	.....	27	24	.....	23	.....	27	.....
1917.												
1	27.4	27.4	19.5	23.6	27.4	16.5	27.4	20.3	27.4	27.4	27.4	14.6
2	27.4	27.4	27.4	22.0	27.4	15.7	24.4	16.5	24.4	24.4	22.0	19.5
3	27.4	27.4	27.4	20.3	23.6	27.4	22.8	16.5	27.4	23.6	18.0	17.2
4	27.4	27.4	22.8	18.8	21.1	27.4	27.4	13.9	27.4	23.6	15.7	18.0
5	27.4	27.4	27.4	17.2	21.1	24.4	27.4	13.9	25.3	24.4	15.7	16.5
6	27.4	27.4	22.0	16.5	27.4	18.8	27.4	13.2	22.7	24.4	13.9	13.9
7	27.4	27.4	27.4	15.7	27.4	17.2	27.4	13.2	18.8	27.4	13.9	16.0
8	24.4	27.4	24.4	15.7	22.8	15.7	27.4	13.2	15.7	25.3	13.2	24.4
9	23.6	27.4	22.8	15.7	19.5	14.6	23.6	12.5	14.6	20.3	13.2	24.4
10	22.0	27.4	23.6	14.6	15.7	27.4	22.0	12.5	13.9	22.0	13.2	23.6
11	27.4	27.4	22.0	13.9	14.6	27.4	25.3	12.5	14.6	23.6	13.2	23.6
12	27.4	27.4	22.0	13.9	14.6	27.4	23.6	11.9	21.1	24.4	13.2	23.6
13	23.6	27.4	20.3	14.6	13.2	25.3	24.4	11.9	16.5	21.1	13.2	20.3
14	27.4	27.4	18.0	14.6	13.2	19.5	21.1	16.5	22.0	19.5	13.9	17.2
15	27.4	27.4	16.5	14.6	13.9	22.8	20.3	15.7	18.0	23.6	13.9	16.5
16	27.4	27.4	15.7	14.6	27.4	25.3	19.5	15.7	24.4	24.4	13.2	13.9
17	27.4	27.4	14.6	13.2	27.4	27.4	19.5	13.9	22.0	27.4	18.0	13.2
18	27.4	27.4	15.7	12.5	26.1	27.4	19.5	13.2	18.0	24.4	24.4	9.9
19	27.4	27.4	27.4	13.2	20.3	27.4	18.8	13.2	19.5	27.4	27.4	15.7
20	27.4	27.4	27.4	13.2	18.0	27.4	18.8	12.5	16.5	25.3	24.4	16.5
21	27.4	27.4	22.8	13.2	15.7	27.4	18.0	27.4	14.6	25.3	22.0	15.7
22	27.4	27.4	22.0	13.2	15.7	27.4	18.0	18.8	14.6	27.4	27.4	20.3
23	25.3	27.4	22.0	13.9	15.7	27.4	17.2	15.7	13.2	27.4	24.4	22.0
24	24.4	27.4	22.0	19.5	14.6	27.4	17.2	13.2	27.4	23.6	23.6	27.4
25	22.8	21.1	23.6	15.7	13.9	27.4	17.2	13.2	24.4	20.3	21.1	22.8
26	22.8	20.3	22.0	17.2	16.5	27.4	17.2	11.9	18.8	18.0	16.5	15.7
27	27.4	20.3	22.0	18.0	18.8	25.3	17.2	11.9	21.1	18.0	16.5	13.9
28	27.4	20.3	22.0	18.0	27.4	25.3	17.2	27.4	18.0	19.5	14.6	13.9
29	27.4	21.1	22.0	16.5	23.6	27.4	27.4	.....	22.0	18.0	14.6	13.9
30	27.4	21.1	20.3	18.0	17.2	27.4	21.1	.....	27.4	23.6	14.6	13.2
31	27.4	21.1	.....	24.4	.....	27.4	.....	.....	27.4	.....	13.9	.....

Digitized by Google

Monthly discharge of Kohala ditch at Niulii weir, near Kohala, Hawaii, for years ending June 30, 1914–17.

Month.	Discharge.				Total run-off.	
	Million gallons per day.			Second-feet (mean).	Million gallons.	Acre-feet.
	Maximum.	Minimum.	Mean.			
1914.						
July	14.9	6.8	11.7	18.1	362	1,110
August	12.8	6.8	9.89	15.3	306	941
September	16.0	6.5	9.30	14.4	279	856
October	14.4	6.2	7.38	11.4	229	702
November	16.5	6.0	10.7	16.6	320	985
December	15.6	6.8	10.8	16.7	336	1,030
January	27.0	14	25.0	38.7	776	2,380
February	27.0	11	16.5	25.5	463	1,420
March	27.0	8.6	17.0	26.3	526	1,620
April	27.0	13	22.5	34.8	675	2,070
May	27.0	16	25.8	39.9	801	2,450
June	27.0	27	27.0	41.8	810	2,490
The year	27.0	8.6	16.1	24.9	5,880	18,100
1915.						
July	27	27	27.0	41.8	837	2,570
August	27	27	27.0	41.8	837	2,570
September	27	27	27.0	41.8	810	2,490
October	27	24	26.7	41.3	828	2,540
November	27	22	26.2	40.5	787	2,410
December	27	27	27.0	41.8	837	2,570
January	27	19	25.7	39.8	797	2,440
February	27	20	26.5	41.0	743	2,280
March	27	18	23.7	36.7	734	2,250
April	27	19	25.2	39.0	756	2,320
May	27	17	23.3	36.1	722	2,220
June	27	16	21.3	33.0	640	1,960
The year	27	16	25.6	39.6	9,330	28,600
1916.						
July	27	17	24.5	37.9	759	2,330
August	27	14	18.4	28.5	570	1,750
September	27	11	15.0	23.2	449	1,380
October	27	13	20.8	32.2	644	1,980
November	27	24	26.6	41.2	799	2,450
December	27	20	25.1	38.8	779	2,390
January	27	24	26.8	41.5	830	2,550
February	27	11	15.7	24.3	456	1,400
March	27	13	20.8	32.2	644	1,980
April	27	13	22.4	34.7	672	2,060
May	27	24	26.8	41.5	830	2,550
June	27	24	26.7	41.3	801	2,460
The year	27	11	22.5	34.8	8,230	25,300
1917.						
July	27.4	22.0	26.4	40.8	819	2,510
August	27.4	20.3	25.9	40.1	803	2,460
September	27.4	14.6	22.2	34.3	665	2,040
October	24.4	12.5	16.3	25.2	506	1,550
November	27.4	13.2	20.0	30.9	601	1,840
December	27.4	14.6	24.5	37.9	760	2,330
January	27.4	17.2	21.8	33.7	677	2,070
February	27.4	11.9	15.1	23.4	422	1,300
March	27.4	13.2	20.6	31.9	639	1,960
April	27.4	18.0	23.5	36.4	705	2,160
May	27.4	13.2	17.7	27.4	550	1,680
June	27.4	9.9	17.9	27.7	537	1,650
The year	27.4	9.9	21.0	32.5	7,680	23,600

Digitized by Google

RAINFALL.

GENERAL CONDITIONS.

The rainfall of the Hawaiian Islands is extremely variable, ranging from a few inches at several low-level, leeward localities to nearly 600 inches per annum, at elevations exceeding 2,000 feet on the windward sides of the islands. Valleys on the same sides of the islands and within a few miles of each other may have a variation in mean annual precipitation of several hundred per cent. The rainfall may also vary greatly in the same valley at different elevations. As a rule the zones of heaviest precipitation are on the windward sides of the islands, 2,000 to 3,000 feet above sea level.

Most of the daily rain gages maintained by the United States Weather Bureau are at low levels. Lack of funds and the absence of residents have prevented the bureau from maintaining stations at high levels, but it obtains a number of daily records from occupants and caretakers of mountain houses and ranches. The data furnished by the Weather Bureau are therefore generally of little value in determining stream run-off.

When high levels have been accessible and funds available high-level rain gages, which are read at monthly, bimonthly, or longer intervals, have been established by this office and some valuable records obtained. To determine the precipitation throughout the Territory accurately would require the installation of thousands of gages and the construction of hundreds of miles of trails. For this reason and because of the extreme and variable porosity of the soil, it is impossible to determine any consistent relation between rainfall and stream run-off.

Acknowledgment for cooperation in furnishing rainfall data is due the following companies and individuals:

Kauai: Kekaha Sugar Co.; Hawaiian Sugar Co.; Grove Farm Plantation; W. F. Sanborn, of Princeville Ranch; Kauai Electric Co.; J. McClellan.

Oahu: F. Meyer; United States Army; Koolau Agricultural Co.; Hawaii Preserving Co.

Maui: Wailuku Sugar Co.; Honolua Ranch; Hawaiian Commercial & Sugar Co.; Maui Board of Supervisors; Pioneer Mill Co.; Olowalu Sugar Co.

Hawaii: Hawaii Mill Co.; W. S. May; C. F. Clark; C. R. Willard; Honokaa Sugar Co.; Pacific Sugar Mill; Hawaiian Irrigation Co.; Kukaiau Ranch Co.; Waiakea Sugar Co.

The tables on pages 185–188 show the precipitation at stations maintained by the Geological Survey and precipitation data furnished from private sources which are not included in United States Weather Bureau records, to which those interested in further data are referred.

Digitized by Google

RAINFALL STATIONS IN HAWAII.

KAUAI.

1. Waialeale, on summit of ridge at headwaters of Hanapepe, Wainiha, Hanalei, and Olokele streams, and North and South forks of Wailua River; about 25 miles by road and trail northeast of Waimea; 5,075 feet above sea level.

2. Intake of Kauai Electric Co.'s canal, 6 miles back of Hanalei; 700 feet above sea level; records furnished by Kauai Electric Co.

3. About 50 feet below Kauai Electric Co.'s power house, at tailrace, 7 miles west of Hanalei; 125 feet above sea level; records furnished by Kauai Electric Co.

4. Summit Camp (Wainiha Ridge), Hanalei; about 30 feet southwest of house at Summit camp on power line; 6 miles from Kapaka; 1,900 feet above sea level; gage read by employee of Kauai Electric Co.

5. Kapaka, at lineman's camp, about 50 feet north of house, and 5 miles south of Hanalei; 635 feet above sea level; gage read by employee of Kauai Electric Co.

6. About 40 feet north of Sanborn's residence, 2 miles from Hanalei; 105 feet above sea level; records furnished by Princeville ranch.

7. Pilaa, about 200 feet north of Government road and 200 feet west of assistant overseer's house; about 2 miles south of Kilauea; 300 feet above sea level. Gage read by Mr. Buch, an employee of Kilauea Sugar Plantation Co.

8. Kaloko, on embankment of Kaloko reservoir about 3 miles southeast of Kilauea; 740 feet above sea level. Gage read by Mr. Buch, an employee of Kilauea Sugar Plantation Co.

9. Residence of W. S. Newlun, about 4½ miles west of Kapaa; 375 feet above sea level.

10. Mount Nonou, near house of Elmer M. Cheatham on west slope of Mount Nonou, about 4 miles west of Kapaa; 350 feet above sea level.

11. North Wailua, at stream-gaging station on North Wailua River, about 1 mile upstream from Kanaha ditch intake, and about 10 miles northwest of Lihue; 650 feet above sea level.

12. Waiahi, on South Wailua River, near Lihue Electric Co.'s power plant, 7 miles from Lihue; 600 feet above sea level.

13. Aakukui, near plantation camp, about 5 miles southwest of Lihue; 350 feet above sea level; records furnished by Grove Farm.

14. Reservoir No. 6, on Grove Farm Plantation, about 5 miles west of Lihue; 400 feet above sea level.

15. At ditchman's house, 500 feet west of Papuaa Reservoir, 6 miles west of Lihue; 500 feet above sea level.

16. Hiloa-Manawaiopuna divide, on ridge between east and west branches of Hanapepe Stream, about 10 miles northeast of Eleele; 2,080 feet above sea level.

17. Hanapepe Valley, on the left bank of Hanapepe ditch, 3 miles above Koula, and about 8 miles north of Eleele; 530 feet above sea level; records furnished by Hawaiian Sugar Co.

18. Camp No. 2, about 2 miles northwest of Hanapepe and 7 miles southeast of Waimea; 250 feet above sea level; records furnished by Hawaiian Sugar Co.

19. Olokele mauka, on ridge on left side of Olokele Stream above intake of Olokele ditch, and about 18 miles by road and trail from Waimea; 2,100 feet above sea level; records furnished by Hawaiian Sugar Co.

20. Keanakua, near Halekua camp, on ridge about 16 miles by road and trail northeast of Waimea; 4,450 feet above sea level.

21. Kahana, near Halekua camp, on ridge about 16 miles by road and trail via Kaholuamanu from Waimea; 3,750 feet above sea level.

22. Kaholuamanu, about 12 miles by road and trail northeast of Waimea; 3,650 feet above sea level.

23. Waimea, in Mr. J. McClellan's yard; 10 feet above sea level; Mr. McClellan aids in obtaining record.

Digitized by Google

24. Camp No. 7, about 2 miles northeast of Waimea; 150 feet above sea level; records furnished by Hawaiian Sugar Co.

25. Pali trail, half a mile mauka of Kekaha ditch where trail crosses and about 2 miles mauka from Waimea; 850 feet above sea level; records furnished by Kekaha Sugar Co.

26. Hukipo, 3 miles northwest of Waimea; 400 feet above sea level; records furnished by Kekaha Sugar Co.

27. Waialae, near Kaholuamanu; 14 miles by road and trail north of Waimea, near Waialae gaging station; 3,600 feet above sea level.

28. Mohiki-Koaie divide, on ridge about 24 miles by road and trail north of Waimea; 3,950 feet above sea level.

29. Mohihi, on ridge at head of Mohihi Valley and about 23 miles by road and trail northeast of Waimea; 3,500 feet above sea level.

30. Kilohana, near Alakai swamp, about 23 miles by road and trail northeast of Waimea; 4,023 feet above sea level.

31. Waiakoali, about 22 miles by road via Halemanu north of Waimea; 3,450 feet above sea level.

32. Paukahana, about 21 miles north of Waimea by road and trail; 3,723 feet above sea level.

33. Lehuamakanoi, about 22 miles by road and trail north of Waimea; 3,932 feet above sea level.

34. Puu Lua, near wagon road from Kekaha to Halemanu, about 12 miles north of Waimea; 3,500 feet above sea level.

35. Kokee, on mesa half a mile above Knudsen's camp, near head of Kokee Stream and about 19 miles north of Waimea; 3,550 feet above sea level.

36. At residence of C. E. French, 3 miles northwest of Kapaa; 350 feet above sea level.

37. At office of Koloa Sugar Co.; 240 feet above sea level.

38. At the stream, gaging station on Kalihiwai River, 10 miles from Hanalei via Kauai Electric Co.'s power line trail; 700 feet above sea level.

OAHU.

1. Nuuanu Pali, on the water reservation, near the Pali road, about 200 yards toward Honolulu, from top of Pali; 1,136 feet above sea level.

2. Manoa, at residence of E. H. Hipple, in upper Manoa Valley, about 500 feet west of highway bridge over the East Branch of Manoa Stream; 300 feet above sea level.

3. Residence of J. K. Maui in upper Kalihi Valley; 550 feet above sea level.

4. At elevation 970 feet in upper Kalihi Valley, about 2 miles above Catholic orphanage.

5. Ditch tenders' house at U. S. Army reservoir in upper valley of the South Kaukonahua Stream; 1,200 feet above sea level.

6. Wahiawa Water Co.'s intake, about 150 yards downstream on left bank of North Fork of Kaukonahua Stream from Wahiawa Water Co.'s ditch intake, on trail 8 miles north of Wahiawa; 1,200 feet above sea level. (Described in Water-Supply Paper 430 as at Waialua Agricultural Co.'s ditch intake.)

7. Hawaiian Preserving Co.'s office, Wahiawa; 950 feet above sea level; records are furnished by Hawaiian Preserving Co.

8. Makaha, near Waianae, on property of Waianae plantation; 1,300 feet above sea level; records furnished by F. Meyer, manager Waianae plantation.

9. About 250 feet from Koloa Stream gaging station, 3 miles by trail southwest of Laie; 550 feet above sea level.

10. Ditch and trail tender's house in upper Punaluu Valley, about 2 miles from Punaluu Railroad station; 300 feet above sea level.

11. On left bank of Maole Stream, at head of first falls in Hillebrand Glen, about 2¼ miles from end of Nuuanu Valley street car line; 1,200 feet above sea level.

Digitized by Google

MAUI.

1. In H. B. Penhallow's yard, Wailuku; 300 feet above sea level.

2. Yard at Wailuku Sugar Co.'s office, Wailuku; 175 feet above sea level.

3. Waikamoi Gulch, on Kula pipe line at reservoir; 3 miles from Olinda and 7 miles from Makawao; 4,200 feet above sea level.

4. Puohakamoa, on Kula pipe line, about 1,000 feet below intake at Puohakamoa Gulch; 4 miles east of Olinda and 8 miles from Makawao; 4,300 feet above sea level.

5. Olinda, on Kula pipe line, 4 miles east of Makawao; 4,000 feet above sea level.

6. Olowalu Sugar Co.'s mill in Olowalu; 10 feet above sea level.

7. West slope of Puu Kukui at top of left bank of Honokawai Gulch; about 6 miles east of Kaanapali and 10 miles from Lahaina; 4,300 feet above sea level.

8. West slope of Puu Kukui, about one-half of a mile south of Honokawai Gulch; about 4½ miles east of Kaanapali and 8½ miles from Lahaina; 2,500 feet above sea level.

9. Honokawai Gulch at junction with Amalu Stream; on trestle supporting Honokawai flume about 1,000 feet below intake; about 3½ miles from Kaanapali and 7½ miles from Lahaina; 1,500 feet above sea level.

10. On ridge between Honokahau and Kahakuloa gulches, beside trail leading to top of Mount Eke; about 12 miles from Honokahau; 2,300 feet above sea level.

11. Honokahau Gulch, at ditchman's house on left bank of stream, 150 feet below ditch intake; about 8 miles from Honokahau; 800 feet above sea level.

12. Rim of extinct crater of Mount Eke; 14 miles by trail from Honokahau; 4,500 feet above sea level.

13. In Waihee Gulch, on bank of Spreckel's ditch; about 5 miles from Wailuku; 275 feet above sea level.

14. Waihee, on roof of building formerly used as plantation office; 3½ miles from Wailuku; 125 feet above sea level.

15. Iao Valley, on small plateau or tableland between north and south branches of Iao Stream, about 1 mile above the junction; about 4 miles west of Wailuku; 1,500 feet above sea level.

HAWAII.

1. Kemole House, 12 miles southeast of Waimea; 5,500 feet above sea level; records furnished by Parker ranch.

2. Pohakuloa, 20 miles southeast of Waimea; 5,700 feet above sea level; records furnished by Parker ranch.

3. Puuhinei Paddock, 14 miles south of Waimea; 1,500 feet above sea level; records furnished by Parker ranch.

4. Puuanuanu Paddock, 14 miles south-southeast of Waimea; 7,500 feet above sea level; records furnished by Parker ranch.

5. Punohu Paddock, 10 miles east of Waimea; 4,200 feet above sea level; records furnished by Parker ranch.

6. Kaauhuhu, on property of W. S. May, about 3 miles northwest of Hawi; 1,400 feet above sea level; records furnished by W. S. May.

7. Kohala Mountain pipe line, 3 miles north of Waimea; 3,700 feet above sea level; records furnished by Parker ranch.

8. Upper Kawainui, in the Kohala Mountains, near the line of the upper Hamakua ditch, near Kukuihaele; 4,080 feet above sea level; records furnished by Hawaiian Irrigation Co.

9. Lower Kawainui, in Waipio Valley, near the line of the lower Hamakua ditch, near Kukuihaele; 1,040 feet above sea level; records furnished by Hawaiian Irrigation Co.

10. Upper Alakahi, in Waipio Valley, Kohala Mountains, near the line of the upper Hamakua ditch; 3,870 feet above sea level; records furnished by Hawaiian Irrigation Co.

Digitized by Google

11. Lower Alakahi, in Waipio Valley, Kohala Mountains, on the line of the lower Hamakua ditch, near Kukuihaele; 1,030 feet above sea level; records furnished by Hawaiian Irrigation Co.

12. Upper Koiawe, on the line of the upper Hamakua ditch, Waipio Valley, near Kukuihaele; 3,350 feet above sea level; records furnished by Hawaiian Irrigation Co.

13. Lower Koiawe, near the line of the lower Hamakua ditch in Waipio Valley near Kukuihaele; 1,000 feet above sea level; records furnished by Hawaiian Irrigation Co.

14. Waimea, in Waipio Valley, along the line of the lower Hamakua ditch, near Kukuihaele; 980 feet above sea level; records furnished by Hawaiian Irrigation Co.

15. Puu Alala; on Upper Hamakua ditch, at east boundary of Government land, about 5 miles northeast of Waimea village; 2,800 feet above sea level.

16. Ahuloa homesteads, at ditch tender's house, near the Parker ranch, Honokaa; 2,551 feet above sea level; records furnished by civil engineer's officer of Honokaa Sugar Co. and Pacific Mill.

17. Upper Hope A, on lands of Kukaiau Ranch Co.; 5,000 feet above sea level. Referred to in previous reports as "Upper Hapea."

18. Lower Hope A, on lands of Kukaiau Ranch Co.; 4,000 feet above sea level. Referred to in previous reports as "Lower Hapea."

19. Kaala, on lands of Kukaiau Ranch Co.; 5,500 feet above sea level.

20. Puu Kea, on lands of Kukaiau Ranch Co.; 8,565 feet above sea level.

21. Halepuila, on lands of Kukaiau Ranch Co; 6,000 feet above sea level.

22. Puu Kihe, on top of Kihe Hill, on the side of Mauna Kea, about 10 miles south of Kukaiau; 7,822 feet above sea level; records furnished by Kukaiau Ranch Co.

23. Umikoa, on property of Kukaiau Ranch Co., near ranch house; 3,400 feet above sea level; records furnished by Kukaiau Ranch Co.

Digitized by Google

Records of rainfall.

Island of Kauai.

No.	Station.	Records available.	Gage.	Readings.	Year ending June 30.	Precipitation. July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Year.
1	Waialeale	Sept. 9, 1910–June 30, 1917 [a].	10 : 1	Irregular	1917													[b]574.0
2	Intake Wainiha power canal.	Feb. 1, 1907–June 30, 1917	Records furnished by Kauai Electric Co.	Daily	1917	15.00	13.51	10.82	12.73	39.68	[c]37.00	(d)	(d)	42.90	18.70	12.10	15.41	
3	Power house, Wainiha.	do	do	do	1917	7.17	9.10	4.95	9.97	26.43	44.66	20.73	6.57	21.16	9.80	7.86	6.63	175.0
4	Summit camp, Hanalei.	Sept. 18, 1910–June 30, 1917	do	do	1917	14.72	12.66	11.84	15.80	22.54	26.72	18.39	4.32	32.97	11.00	16.16	17.45	204.6
5	Kapaka	do	do	do	1917	9.77	8.82	6.19	12.42	16.90	25.75	19.83	5.47	29.47	7.58	11.35	9.38	162.9
6	Sanborn's house, Hanalei.	Mar. 11, 1910–June 30, 1917	Records furnished by W. F. Sanborn.	do	1917	6.19	4.98	4.69	7.72	14.77	19.20	12.11	3.93	20.25	4.61	7.13	7.38	113.0
7	Pilaa	June 1, 1914–June 30, 1917	Records furnished by T. B. Buch.	do	1917	3.73	3.70	8.40	5.40	10.40	11.40	12.11	2.47	19.95	2.27	7.23	3.62	90.7
8	Kaloko	do	do	do	1917	6.00	2.25	2.30	2.42	6.62	8.71	15.80	2.80	24.00	5.20	11.00	5.40	92.5
9	Newlun's house	do	do	do	1917													82.2
10	Mount Nonou	Feb. 1, 1915–June 30, 1917	Records furnished by E. M. Cheatham.	Monthly	1917	4.7	3.4	4.4	5.2	10.5	11.4	7.4	3.6	19.5	2.7	6.5	5.5	84.8
11	North Wailua	Sept. 25, 1914–June 30, 1917	2 : 1	Irregular	1917													113.1
12	Waiahi	Aug. 8, 1910–June 30, 1917	2 : 1	Monthly	1917	10.20	9.20	11.20	11.10	15.40	20.80	13.00	2.20	19.50	7.00	12.40	9.20	141.2
13	Aakukui	June 1, 1909–June 30, 1917	Records furnished by Grove Farm.	Daily	1917	3.50	2.70	3.50	6.42	9.38	10.86	6.58	4.86	14.28	5.52	6.63	4.74	79.0
14	Reservoir No. 6	Jan. 1, 1914–June 30, 1917	do	do	1917	4.48	3.50	3.72	8.61	9.50	11.91	6.76	4.67	14.80	8.04	8.18	5.63	89.8
15	Papuaa	July 1, 1915–June 30, 1917	do	do	1916	2.50	7.50	11.55	10.56	14.61	11.61	17.88	3.04	16.10	3.92	9.82	6.89	120.5
					1917	7.54	6.91	7.22	11.25	13.33	17.01	8.88	7.89	22.63	10.43	10.78	8.40	112.4
16	Hiloa-Manawaiopuna divide.	Aug. 24, 1910–June 30, 1917	2 : 1	Monthly	1917	21.80	18.0	18.2	29.4	33.4	51.6	22.6	9.6	27.8	17.2	20.2	15.6	287.4
17	Hanapepe Valley	Jan. 1, 1905–June 30, 1917	Records furnished by Hawaiian Sugar Co.	Daily	1917	10.56	9.15	8.73	13.97	20.34	25.83	13.86	7.51	20.01	7.88	13.97	8.51	160.3
18	Camp No. 2	do	do	do	1917	1.39	1.28	1.48	2.53	1.94	5.15	7.04	4.07	8.30	2.13	0	1.08	36.4
19	Olokele mauka	Apr. 1, 1911–June 30, 1917	do	Monthly	1917	11.20	8.80	9.95	23.50	23.50	24.30	19.20	14.80	23.50	12.30	18.25	9.50	198.8
20	Keanakua	Sept. 6, 1910–June 30, 1917	2 : 1	Irregular	1917													147.0
21	Kahana	Aug. 1, 1910–June 30, 1917	2 : 1	do	1917													147.4
22	Kaholuamanu	Mar. 11, 1913–June 30, 1917	2 : 1	do	1917													89.4
23	Waimea	Jan. 1, 1913–June 30, 1917	Records furnished by Jas. McClellan.	Daily	1917	.15	.10	.37	1.90	.71	4.50	5.77	3.47	9.24	3.85	3.03	.23	33.3

[a] Broken record. [b] July 14, 1916–Aug. 13, 1917. [c] Record Dec. 1–20. [d] No record.

Digitized by Google

Records of rainfall—Continued.

Island of Kauai—Continued.

No.	Station.	Records available.	Gage.	Readings.	Year ending June 30.	Precipitation. July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Year.
24	Camp No. 7	Jan. 1, 1914–June 30, 1917	Records furnished by Hawaiian Sugar Co.	Daily	1917	11.00	0	0.41	1.66	1.84	5.72	5.41	3.02	8.44	2.76	3.10	0.10	43.5
25	Pali trail	Jan. 1, 1911–June 30, 1917	Records furnished by Kekaha Sugar Co.	do	1917	T.	T.	T.	1.40	.50	1.85	5.75	3.90	1.40	1.55	1.50	0	17.8
26	Hukipo	do	do	do	1917	T.	T.	T.	1.90	1.00	1.65	5.95	3.90	7.90	2.25	1.25	0	25.8
27	Waialae	July 31, 1910–June 30, 1917	2 : 1	Irregular	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	122.6
28	Mohihi-Koaie divide.	June 24, 1910–June 30, 1917	2 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	138.2
29	Mohihi	June 21, 1910–June 30, 1917	2 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	127.9
30	Kilohana	June 18, 1910–June 30, 1917	5 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	244.0
31	Waiakoali	June 4, 1910–June 30, 1917	2 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	109.2
32	Paukahana	do	2 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	115.6
33	Lehuamakanoi	June 18, 1910–June 30, 1917	5 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	170.0
34	Puu Lua	June 5, 1910–June 30, 1917	2 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	55.6
35	Kokee	June 6, 1910–June 30, 1917	2 : 1	do	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	73.9
36	Konohiki	June 1, 1916–June 30, 1917	Records furnished by C. E. French.	Monthly	1917	4.75	3.36	3.75	4.20	8.80	10.40	7.80	2.80	20.20	3.40	6.90	4.00	80.4
37	Koloa	July 1, 1916–June 30, 1917	Records furnished by M. J. Teves.	Daily	1917	4.69	5.08	3.93	6.03	9.85	10.72	6.68	4.98	14.14	3.69	6.49	2.31	78.6
38	Kalihiwai	May 26, 1914–June 30, 1917	2 : 1	Irregular	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	a230.0

Island of Oahu.

1	Nuuanu Pali	Sept. 23, 1910–June 30, 1917	2 : 1	Monthly	1917	5.6	7.8	6.9	7.3	8.9	16.0	14.0	5.0	30.0	12.0	13.9	3.7	131.1
2	Manoa	May 17, 1915–June 30, 1917	1 : 10	Daily	1917	12.99	18.85	9.15	9.28	16.56	23.84	13.56	3.44	21.00	15.43	12.78	6.90	163.8
3	Kalihi	Sept. 8, 1914–June 30, 1917	1 : 10	do	1917	9.62	10.56	7.75	11.78	15.47	23.14	12.65	3.16	29.12	10.71	11.14	5.16	150.3
4	Kalihi mauka	Feb. 7, 1917–June 30, 1917	2 : 1	Monthly	1917	.....	.....	.....	.....	.....	.....	.....	3.2	36.6	14.2	13.2	7.0	.....
5	Army reservoir	Aug. 1, 1914–June 30, 1917	1 : 10	Daily	1917	10.27	15.36	9.95	12.80	14.85	24.23	15.90	3.35	17.02	7.03	14.78	5.89	151.3
6	Wahiawa Water Co.'s intake.	May 30, 1913–June 30, 1917	2 : 1	Monthly	1917	23.1	21.9	18.8	32.7	30.4	35.3	17.6	6.0	36.1	28.6	29.2	11.3	291.0
7	Hawaii Preserving Co.	May 1, 1913–June 30, 1917	Records furnished by Hawaii Preserving Co.	Daily	1917	2.74	2.87	1.63	4.66	5.29	12.42	11.92	2.88	12.58	1.68	5.45	1.48	65.6

Digitized by Google

8	Makaha	Aug. 1, 1912–June 30, 1917	Records furnished by F. Meyer.	...do	1917	3.67	2.70	2.42	6.24	6.52	10.93	14.52	4.36	13.54	9.01	5.89	2.10	81.9
9	Koloa	Oct. 30, 1915–June 30, 1917	2 : 1	Irregular	1917	.....	.....	5.45	3.25	8.85	9.45	8.85	10.65	14.25	13.75	11.65	3.65	.....
10	Upper Punaluu Valley.	Apr. 28, 1915–June 30, 1917	1 : 10	Daily	1917	7.36	10.54	7.40	10.34	10.31	16.92	15.05	6.07	26.65	12.65	9.57	4.55	137.4
11	Hillebrand Glen No. 2.	May 6, 1916–June 30, 1917	2 : 1 [b]	Monthly	1917	10.55	14.02	9.44	15.35	15.78	25.86	14.07	3.80	34.20	14.40	18.80	7.00	183.3

Island of Maui.

1	Penhallow's residence, Wailuku.	Nov. 1, 1896–June 30, 1917	Records furnished by Wailuku Sugar Co.	Daily	1917	0.54	0.24	0	.59	1.24	8.75	2.44	4.22	4.14	5.32	0.46	0.31	28.2
2	Wailuku	May 1, 1887–June 30, 1917	...do	...do	1917	.68	.06	.12	.27	.92	7.31	2.42	3.89	3.65	3.97	.91	.08	24.3
3	Waikamoi Gulch	Oct. 12, 1910–June 30, 1917	Records furnished by Maui County Engineer.	...do	1917	.....	19.73	23.28	10.98	43.38	c75.32	13.00	6.49	10.12	20.44	12.37	11.48	.....
4	Puohakamoa	May 1, 1911–June 30, 1917	...do	...do	1917	.....	29.43	21.68	8.79	37.79	c71.69	12.40	6.06	8.81	19.36	17.42	9.68	.....
5	Olinda	Sept. 26, 1910–June 30, 1917	...do	...do	1917	.....	2.06	4.18	2.42	7.50	30.10	4.43	5.15	6.00	6.97	7.70	1.90	.....
6	Olowalu	Jan. 1, 1907–June 30, 1917	Records furnished by Olowalu Co.	...do	1917	.15	0	.14	0	0	4.82	10.72	4.23	16.63	1.05	.87	.11	33.7
7	Puukukui (upper slope).	Oct. 11, 1913–June 30, 1917	Records furnished by Pioneer Mill Co.	Monthly	1917	23.0	33.0	20.4	21.2	30.6	c50	14.5	8.0	30.0	27.0	24.0	16.0	.....
8	Puukukui (lower slope).	Oct. 13, 1913–June 30, 1917	...do	...do	1917	7.8	11.4	3.2	9.9	14.6	29.6	8.0	8.0	6.0	9.8	6.6	1.2	116.1
9	Honokawai Gulch.	Oct. 17, 1911–Mar. 14, 1917	...do	...do	1917	9.23	.....	6.46	7.06	14.44	28.61	7.30	4.41	d2.96	.....	.....	.....	.....
10	Honokahau Ridge.	Mar. 10, 1913–June 30, 1917	2 : 1	...do	1917	11.0	13.4	9.6	9.4	11.6	27.0	6.0	6.8	10.6	4.6	21.6	4.6	136.2
11	Honokahau Gulch	Feb. 1, 1907–June 30, 1917	Records furnished by Honolua ranch.	Daily	1917	11.67	17.77	11.61	11.61	16.34	40.08	5.93	6.67	13.69	18.42	11.30	6.23	171.3
12	Mount Eke	Mar. 10, 1913–June 30, 1917	5 : 1 [e]	Monthly	1917	25.6	24.8	25.4	20.0	24.2	c50.0	11.4	7.2	23.4	14.2	32.5	10.0	.....
13	Waihee (upper)	July 1, 1915–June 30, 1917	Records furnished by H. C. & S. Co.	Daily	1917	1.44	.39	.30	.48	1.74	7.30	2.14	4.53	4.72	4.17	.32	.16	27.7
14	Waihee (lower)	Jan. 1, 1899–Oct. 31, 1907 Jan. 1, 1910–June 30, 1917	Records furnished by Wailuku Sugar Co.	...do	1917	1.69	.80	.82	1.10	0	8.43	2.82	4.47	6.14	3.65	.45	.79	31.2
15	Iao Valley Tableland.	Apr. 12, 1911–June 30, 1917	2 : 1	Irregular	1917	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	111.7

a Approximate.
b A daily rain gage was maintained by the Water Commission of Territory of Hawaii at this station until Jan. 1, 1917.
c Gage overflowed.
d Gage carried away by freshet Mar. 15, 1917.
e Monthly gage 2 : 1 replaced by "150-inch" gage 5: 1 Apr. 28, 1917.

Digitized by Google

Records of rainfall—Continued

Island of Hawaii.

No.	Station.	Records available.	Gage.	Readings.	Year ending June 30.	Precipitation.												
						July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Year.
1	Kemole House	Sept. 1, 1914–June 30, 1917	Records furnished by Parker ranch.	Monthly	1917	4.0	0.8	0.8	1.8	2.8	3.2	2.4	1.0	6.5	3.5	6.0	2.4	35.2
2	Pohakuloa	do	do	do	1917	0	.4	0	2.2	0	34.2	1.6	.8	.8	10.2	6.2	.2	56.6
3	Puuhinei paddock	do	do	do	1917	0	2.4	.6	2.8	1.2	3.4	2.0	2.1	2.8	.1	6.1	.7	24.2
4	Puuanuanu paddock.	do	do	do	1917	.8	4.0	.....	2.0	2.0	3.8	1.6	1.5	7.0	9.1	9.4	3.2	.....
5	Punohu paddock	Nov. 1, 1914–June 30, 1917	do	do	1917	4.0	1.6	1.2	2.4	3.5	15.0	2.6	3.4	14.5	2.5	2.4	1.8	54.9
6	Kaauhuhu	Mar. 18, 1913–June 30, 1917	Records furnished by W. S. May, Hawi.	Daily	1917	4.75	4.47	3.40	1.90	2.01	8.50	5.97	5.14	.....	4.19	5.95	3.50	.....
7	Kohala Mountain pipe line.	Sept. 1, 1914–June 30, 1917	Records furnished by Parker ranch.	Monthly	1917	10.0	10.0	7.0	5.0	8.8	21.5	16.0	4.0	10.8	5.5	8.0	10.0	116.6
8	Upper Kawainui	Sept. 1, 1910–June 30, 1917	Records furnished by Hawaiian Irrigation Co.	Daily	1917	18.80	19.55	13.48	8.06	10.28	27.49	5.46	5.86	10.48	11.99	8.00	12.18	151.6
9	Lower Kawainui	do	do	do	1917	14.32	10.34	7.89	4.85	8.59	28.93	3.61	8.21	3.92	15.00	4.54	7.72	117.9
10	Upper Alakahi	Jan. 1, 1913–June 30, 1917	do	do	1917	18.68	15.27	11.61	6.66	7.58	25.22	3.76	5.56	10.03	13.72	8.12	11.55	137.8
11	Lower Alakahi	Sept. 1, 1910–June 30, 1917	do	do	1917	8.48	7.63	5.36	3.30	6.66	22.64	2.77	6.01	3.35	10.28	4.24	5.66	86.4
12	Upper Koiawe	Jan. 1, 1912–June 30, 1917	do	do	1917	13.91	10.85	7.79	4.67	5.89	20.03	3.26	4.64	6.62	12.49	6.34	7.87	104.4
13	Lower Koiawe	Sept. 1, 1910–June 30, 1917	do	do	1917	7.74	6.71	5.31	2.51	4.00	18.44	2.32	5.00	2.19	7.69	3.15	4.13	69.2
14	Waima	Apr. 1, 1913–June 30, 1917	do	do	1917	2.14	3.95	2.14	.78	2.64	16.80	.42	3.47	.80	4.50	.65	4.81	43.1
15	Puu Alala	July 1, 1915–June 30, 1917	do	do	1917	4.71	3.95	2.98	2.18	6.69	29.48	2.97	6.41	6.42	12.31	4.57	4.47	87.1
16	Ahualoa Homesteads.	Jan. 1, 1912–June 30, 1917	do	do	1917	7.00	5.61	3.59	.25	6.55	39.00	2.78	7.65	2.10	3.41	.87	1.06	79.9
17	Upper Hope A	Mar. 1, 1902–June 30, 1917	Records furnished by Kukaiau ranch.	Irregular	1917	0	.82	.25	.60	4.30	16.65	0	3.10	4.11	3.81	6.42	0	.....
18	Lower Hope A	Apr. 1, 1909–June 30, 1917	do	do	1917	.75	0	1.18	.25	5.30	24.00	0	2.20	3.80	4.20	.80	0	.....
19	Kaala	Jan. 14, 1913–June 30, 1917	do	do	1917	.84	2.59	1.24	1.07	6.96	16.62	2.40	4.60	3.45	2.30	4.26	.47	46.8
20	Puu Kea	June 1, 1914–June 30, 1917	do	Monthly	1917	.....	.....	.05	.....	3.00	9.80	.....	.....	3.40	4.20	3.90	0	.....
21	Halepiula	Dec. 1, 1914–June 30, 1917	do	do	1917	.....	1.53	.30	1.00	4.41	18.12	2.65	.10	5.15	2.40	6.00	.14	.....
22	Puu Kihe	Mar. 1, 1903–June 30, 1917	do	do	1917	.....	.50	.20	.....	6.40	17.10	.30	.....	9.70	2.00	4.90	0	.....
23	Umikoa	Jan. 1, 1895–June 30, 1917	do	Daily	1917	.69	2.73	.25	.57	7.84	34.55	1.80	5.24	3.51	1.36	3.99	.46	63.0

Digitized by Google

INDEX.

A. Page.

Accuracy of data and results, degrees of..... 22
Acre-foot, definition of..... 16
equivalent of..... 17
Alo Stream near Huelo, Maui..... 156–158
Anahola ditch near Kealia, Kauai..... 64–66, 79
River near Kealia, Kauai..... 63–64
Authority for investigations..... 7–8

B.

Bridge gaging station, description of..... 15

C.

Cable gaging station, description of..... 15
China ditch near Hanalei, Kauai..... 70–72
Clark, C. F., cooperation by..... 180
College of Hawaii, Oahu, Manoa Stream at.. 83–84
Computing discharge and run-off, methods of 18–21
Cooperation by Hawaii..... 9
by various parties..... 9–10
Current meter, penta-recording, description of 11

D.

Definition of terms..... 15–17
Discharge, table for converting, into run-off.. 17
Discharge and run-off, computing and studying of..... 18–21

E.

East Manoa ditch, Oahu, discharge of..... 119
East Maui Irrigation Co., cooperation by.... 10
East Wailuaiki Stream near Keanae, Maui. 145–147
East Wailuanui Stream near Keanae, Maui. 148–150
Eleele, Kauai, Hanapepe ditch near..... 48–49
Hanapepe River near..... 46–47
Equivalents, convenient..... 17

G.

Gaging stations, classes of..... 11, 14–15
list of..... 22–28
Gaging streams, process of..... 15
Grove Farm Plantation, cooperation by..... 180

H.

Haiku ditch near Huelo, Maui..... 170–171
Haiku Stream near Heeia, Oahu..... 90–91
Haipuaena Stream near Huelo, Maui..... 153–154
Hamakua ditches, Upper and Lower, near Kukuihaele, Hawaii..... 171–173
Hanalei, Kauai, China ditch near..... 70–72
Lumahai River near..... 73–75
Kalihiwai River near..... 66–67
Kuna ditch near..... 72–73
Waioli Stream near..... 75–76
Hanalei River near Hanalei, Kauai..... 67–70
Hanamanlu ditch near Lihue, Kauai..... 52–53

Page.

Hanapepe ditch near Eleele, Kauai..... 48–49
near Hanapepe, Kauai..... 49–50
Hanapepe River near Eleele, Kauai..... 46–47
Hauula, Oahu, Kaluanui Stream near..... 98–100
Hawaii Island, gaging-station records on... 171–179
gaging stations on..... 27–28
rainfall records on..... 188
rainfall stations on..... 183–184
Hawaii Mill Co., cooperation by..... 180
Hawaii Preserving Co., cooperation by..... 180
Hawaiian Commercial & Sugar Co., cooperation by..... 180
Hawaiian Irrigation Co., cooperation by..... 180
Hawaiian Sugar Co., cooperation by..... 10, 180
Heeia, Oahu, Haiku Stream near..... 90–91
Honokaa Sugar Co., cooperation by..... 180
Honokahau, Maui, Honolua Stream near.. 122–123
Honokahau Stream near Honokahau, Maui 120–122
Honokawai ditch near Lahaina, Maui..... 125–126
Honokawai Stream near Lahaina, Maui... 123–124
Honolua Ranch, cooperation by..... 10, 180
Honolua Stream near Honokahau, Maui.. 122–123
Honolulu, Oahu, cooperation by..... 9
East Branch of Manoa Stream near..... 87–88
Kalihi Stream near..... 79–81
Manoa Stream near..... 83–84
Nuuanu Stream near..... 81–82
West Branch of Manoa Stream near..... 85–86
Honomanu Stream near Keanae, Maui.... 151–153
Honopu Stream near Huelo, Maui..... 165–167
Hoolawaliilii Stream near Huelo, Maui..... 162–164
Hoolawanui Stream near Huelo, Maui.... 164–165
Horsepower, equivalents of..... 17
Huelo, Maui, Alo Stream near..... 156–158
Haiku ditch near..... 170–171
Haipuaena Stream near..... 153–154
Honopu Stream near..... 165–167
Hoolawanui Stream near..... 164–165
Hoolawaliilii Stream near..... 162–164
Kailua Stream near..... 161–162
Kauhikoa ditch near..... 168–169
Lowrie ditch near..... 169–170
Nailiilihaele Stream near..... 159–161
New Hamakua ditch near..... 167–168
Puohakamoa Stream near..... 155–156
Waikamoi Stream near..... 158–159

K.

Kahana Stream near Kahana, Oahu..... 91–93
East Branch of, near Kahana, Oahu..... 93–94
Kahawainui Stream, East Branch of, near Laie, Oahu..... 103–104
Kaholalele ditch, discharge of..... 79
Kahoma development tunnel near Lahaina, Maui..... 128–129
Kahoma Stream near Lahaina, Maui..... 126–127

Digitized by Google

Page.
Kahuku, Oahu, East Branch of Malaekahana Stream near..... 105-106
Middle Branch of Malaekahana Stream near..... 106-108
Kahuku Plantation, cooperation by..... 10
Kailua, Oahu, main spring near..... 89-90
Makawao spring near..... 89
Kailua Stream near Huelo, Maui..... 161-162
Kalihi Stream near Honolulu, Oahu..... 79-81
Kalihiwai River near Hanalei, Kauai..... 66-67
Kaluanui Stream near Hauula, Oahu..... 98-100
Kamenehune ditch near Waimea, Kauai.... 40-42
Kanaha ditch near Lihue, Kauai..... 56-58
Kaneohe Ranch Co., cooperation by..... 10
Kapaa River near Kealia, Kauai..... 59-61
Kapahi ditch near Kealia, Kauai..... 61-62
Kauai Electric Co., cooperation by..... 10. 180
Kauai Island, gaging stations on..... 22-24
gaging-station records on..... 28-79
miscellaneous measurements on..... 79
rainfall records on..... 185-186
rainfall stations on..... 181-182
Kauaikanana Stream, discharge of..... 79
Kauaula ditch near Lahaina, Maui..... 132-134
Kanaula Stream near Lahaina, Maui..... 131-132
Kauhikoa ditch near Huelo, Maui..... 168-169
Kaukonahua Stream, right and left branches of North Fork of, near Waihaiwa, Oahu..... 108-109, 109-111
South Fork of, near Wahaiwa, Oahu.. 111-112, 113-114
Kawaikoi Stream near Waimea, Kauai..... 30-31
Kealia, Kanai, Anahola ditch near..... 64-66
Anahola River near..... 63-64
Kapaa River near..... 59-61
Kapahi ditch near..... 61-62
Keanae, Maui, East Wailuaiki Stream near. 145-147
East Wailuanui Stream near..... 148-150
Honomanu Stream near..... 151-153
West Kopiliula Stream near..... 143-145
West Wailuaiki Stream near..... 147-148
West Wailuanui Stream near..... 150-151
Kekaha ditch near Waimea, Kauai..... 36-38
Kehaka Sugar Co., cooperation by..... 180
Koale River near Waimea, Kauai..... 32-34
Kohala ditch near Kohala, Hawaii. 173-176, 176-179
Koloa Stream near Laie, Oahu..... 100-101
Koolau Agricultural Co., cooperation by.... 10, 180
Kopiliula Stream, West, near Keanae, Maui.. 143-145
Koula, Kauai, Hanapepe ditch at..... 48-49
Hanapepe River at..... 46-47
Kukaiau Ranch Co., cooperation by..... 180
Kukuihaele, Hawaii, Upper Hamakua ditch near..... 171-172
Kuna ditch near Hanalei, Kauai..... 72-73

L.

Lahaina, Maui, Honokawai ditch near..... 125-126
Honokawai Stream near..... 123-124
Kahoma development tunnel near..... 128-129
Kahoma Stream near..... 126-127
Kauaula ditch near..... 132-134
Kauaula Stream near..... 131-132
Lahainaluna Stream near..... 129-130
Launiupoko Stream near..... 134-135
Page.
Laie, Oahu, East Branch of Kahawainui Stream near..... 103-104
Koloa Stream near..... 100-101
Wailele Stream near..... 101-103
Laie Plantation, cooperation by..... 10
Larrison, G. K., and assistants, work of..... 22
Lahainaluna Stream near Lahaina, Maui.. 129-130
Launiupoko Stream near Lahaina, Maui... 134-135
Lihue, Kauai, East Branch of North Fork of Wailua River near..... 58-59
Hanamaulu ditch near..... 52-53
Kanaha ditch near..... 56-58
North Fork of Wailua River near..... 55-56
South Fork of Wailua River near..... 50-52
Lihue ditch near Lihue, Kauai..... 53-55
Lihue Plantation Co., cooperation by..... 10
Lower Hamakua ditch near Kukuihaele, Hawaii..... 172-173
Lowrie ditch near Huelo, Maui..... 169-170
Lumahai River near Hanalei, Kauai..... 73-75

M.

McClellan, J., cooperation by..... 180
Makawao Spring near Kailua, Oahu..... 89
Makaweli, Kauai, Olokele ditch near..... 43-46
Makaweli River near Waimea, Kauai..... 42-43
Makee Sugar Co., cooperation by..... 10
Malaekahana Stream, East Branch of, near Kahuku, Oahu..... 105-106
Middle Branch of, near Kahuku, Oahu. 106-108
Manoa Stream near Honolulu..... 83-84
East Branch of, near Honolulu..... 87-88
West Branch of, near Honolulu..... 85-86
Man's water, definition of..... 16-17
Maui Board of Supervisors, cooperation by.... 180
Maui Island, gaging-station records on.... 115-171
gaging stations on..... 25-27
miscellaneous measurements on..... 171
rainfall records on..... 187
rainfall stations on..... 183
Maunawili Ranch, cooperation by..... 10
May, W. S., cooperation by..... 180
Measurement of stream flow, methods of.... 10-15
Measures, English, metric equivalents of..... 17
Meyer, F., cooperation by..... 180
Miner's inch, definition of..... 16
Mohihi Stream, discharge of..... 79

N.

Nailiilihaele Stream near Huelo, Maui..... 159-161
New Hamakua ditch near Huelo, Maui.... 167-168
North Waiehu ditch near Wailuku, Maui.. 116-118
North Waiehu Stream, discharge of..... 171
Nuuanu Stream near Honolulu, Oahu..... 81-82

O.

Oahu Island, gaging-station records on..... 79-115
gaging stations on..... 24-25
miscellaneous measurements on..... 115
rainfall records on..... 186-187
rainfall stations on..... 182
Olokele ditch near Makaweli, Kauai..... 43-46
Olowalu, Maui, Ukumehame Stream near. 137-139
Olowalu ditch near Olowalu, Maui.... 135-137, 171
Olowalu Sugar Co., cooperation by..... 10, 180
Opaikaa Stream, discharge of..... 79

Digitized by Google

P. Page.

Pacific Sugar Mill, cooperation by..... 180
Palolo ditch near Waikapu, Maui..... 140-142
Pioneer Mill Co., cooperation by..... 10, 180
Punaluu, Oahu, Waihoi Stream near..... 97-98
Punaluu Stream near Punaluu, Oahu... 94-97, 115
Puohakamoa Stream near Huelo, Maui.... 155-156

R.

Rainfall of the islands..... 180-188
Results, accuracy of..... 22
Rice, Charles, cooperation by..... 10
Run-off, definition of..... 16
table for converting discharge into..... 17
Run-off and discharge, computing and studying of..... 18-21

S.

Sanborn, W. F., cooperation by..... 180
Scope of work..... 10
Second-foot, definition of..... 19
equivalents of..... 17
South Side Waikapu ditch near Waikapu, Maui..... 142-143
South Waiehu Stream near Wailuku, Maui. 115-116
Spreckels ditch, Maui, discharge of..... 171
Stream flow, methods of measuring..... 10-15

T.

Tables, explanation of..... 21-22
Terms, definitions of..... 15-17

U.

Ukumehame Stream near Olowalu, Maui.. 137-136
U. S. Army Constructing Quartermaster Department, cooperation by.... 10, 180
U. S. Army reservoir near Wahaiwa, Oahu, south fork of Kaukona Stream near..... 111-112, 113-114
Upper Hamakua ditch near Kakuihaele, Hawaii..... 171-172

V.

Velocity, mean, position of thread of..... 13
Velocity-area method of measuring streams, description of..... 11-15

W. Page.

Wading gaging station, description of..... 14-15
Wahiawa Water Co., cooperation by..... 10
Waiahulu Stream near Waimea, Kauai..... 31-32
Waiakea Sugar Co., cooperation by..... 180
Waiakoali Stream, Kauai, discharge of..... 79
Waialae River near Waimea, Kauai..... 34-35
Waihaiwa, Oahu, right and left branches of North Fork of Kaukonahua Stream near..... 108-109, 109-111
Waihee Stream near Waihee, Maui..... 118-120
Waihoi Stream near Punaluu, Oahu..... 97-98
Waihoi Stream, north and south forks of, Oahu, discharge of..... 115
Waikamoi Stream near Huelo, Maui..... 158-159
Waikapu, Maui, Palolo ditch near..... 140-142
South Side Waikapu ditch near..... 142-143
Waikapu Stream near Waikapu, Maui..... 139-140
Wailele Stream near Laie, Oahu..... 101-103
Wailua River, East Branch of North Fork of, near Lihue, Kauai..... 58-59
North Fork of, near Lihue, Kauai..... 55-56
South Fork of, near Lihue, Kauai..... 50-52
Wailuaiki streams, East and West, near Keanae, Maui..... 145-148
Wailuanui streams, East and West, near Keanae, Maui..... 148-151
Wailuku, Maui, North Waiehu ditch near. 116-118
South Waiehu Stream near..... 115-116
Wailuku Sugar Co., cooperation by..... 10, 180
Waimea, Kauai, Kamenehune ditch near.... 40-42
Kawaikoi Stream near..... 30-31
Kekaha ditch near..... 36-38
Koaie River near..... 32-34
Makaweli River near..... 42-43
Waiahulu Stream near..... 31-32
Waialae River near..... 34-35
Waimea ditch near Waimea, Kauai..... 39-40
Waimea River near Waimea, Kauai..... 28-30
Waimea Sugar Co., cooperation by..... 10
Wainiha Canal, discharge of..... 79
Wainiha River near Wainiha, Kauai..... 76-78, 79
Waioli Stream near Hanalei, Kauai..... 75-76
Water power, quick method of calculating... 17
Water-stage recorder, description of..... 15
Weir measurements, accuracy of..... 11
West Kopiliula Stream near Keanae, Maui. 143-145
West Wailuaiki Stream near Keanae, Maui. 147-148
West Wailuanui Stream near Keanae, Maui..... 150-151
Willard, C. R., cooperation by..... 180

O

Digitized by Google

Digitized by Google

Stanford University Libraries
3 6105 007 639 110

FOR USE IN LIBRARY BUILDING ONLY
DO NOT REMOVE
792400

Digitized by Google

Digitized by Google

Stanford University Libraries
3 6105 007 639 110

FOR USE IN LIBRARY BUILDING ONLY
DO NOT REMOVE
792400

Digitized by Google

Digitized by Google